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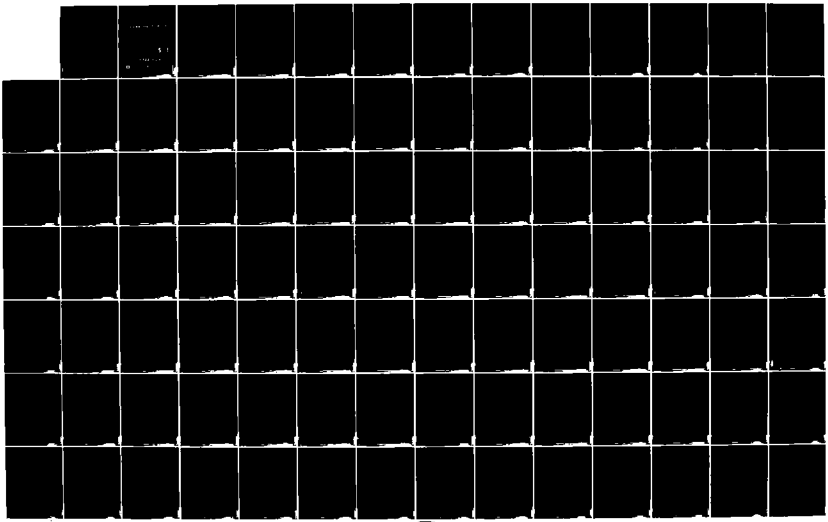

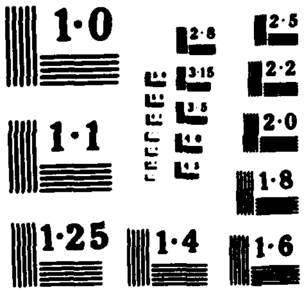
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TECHNICAL APPENDIXES
VOLUME 2

OF THE

GENERAL REEVALUATION

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ENVIRONMENTAL IMPACT STATEMENT

FOR

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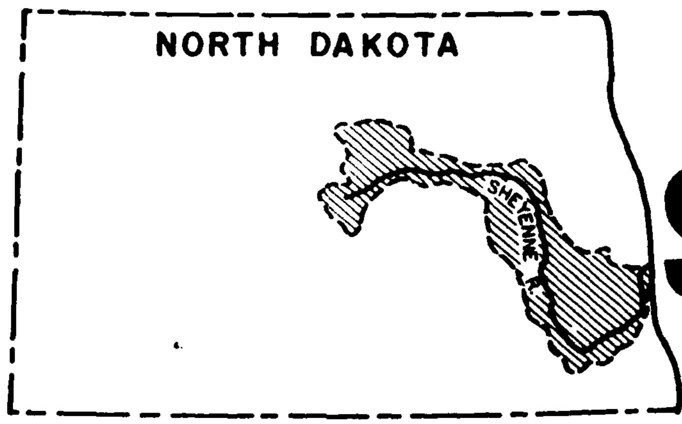

SHEYENNE RIVER
NORTH DAKOTA

US Army Corps of Engineers
St. Paul District

AUGUST 1982

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report addresses the water resource and related problems and needs of the lower Sheyenne River basin with particular emphasis on reducing flood damages. The technical appendixes present detailed information used in investigating the problems and needs, assessing the impacts of the alternatives, and evaluating the alternatives and technical details of the selected plan.

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SHEYENNE RIVER, NORTH DAKOTA

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PREFACE

The General Reevaluation and Environmental Impact Statement for flood control and related purposes in the Sheyenne River basin, North Dakota, presents the findings, conclusions, and recommendations of studies conducted from February 1976 through August 1982.

The report addresses the water resource and related problems and needs of the lower Sheyenne River basin with particular emphasis on reducing flood damages - the most significant local water resource need. The goal of the reevaluation is to identify a plan for water resource development that meets the needs of the basin, is consistent with the national objective of economic development and the national considerations for environmental quality, and is implementable.

The study completely reevaluates and reformulates work done during the feasibility study (1963 through 1968). The 1968 feasibility report recommended construction of the multiple-purpose Kindred Lake project. The Kindred Lake project would reduce flood damages, improve water quality, provide for recreation, and enhance fish and wildlife. The report also recommended that Baldhill Dam be operated to provide more flood control storage before spring runoff.

In 1970, Congress authorized the Kindred Lake project for construction. Before funds were appropriated for the reevaluation, special studies examined the effects the project would have on groundwater levels in the Sheyenne National Grassland, the potential shoreline erosion around Kindred Lake, and the effects the project would have on water quality. In 1976, following completion of these studies, the Corps received appropriations to begin the reevaluation.

Several events occurred between completion of the feasibility study (1968) and the start of the reevaluation studies (1976) that significantly cahnged planning guidwlines. These changes required a complete reevaluation of the study area. The events included:

1. Passage of the National Environmental Policy Act of 1969,

2. Completion of the special studies (1974),

3. Adoption by the Water Resources Council of new principles and standards for planning water and related land resources (1973), and

4. Uncertainty in the status of the Garrison Diversion Unit (1975 and 1976).

The principal elements of the water resource plan selected on the basis of the reevaluation and presented in this report are:

- Adoption (or continuation) and enforcement of floodplain regulations in flood-prone areas of the basin (non-Federal implementation).

- Regulation of drainage to ensure that future drainage of wetlands would not increase downstream flood damages (non-Federal implementation).

- Control of private levee construction to prevent increases in upstream and/or downstream flood damages (non-Federal implementation).

- Levees and a flood diversion channel at West Fargo/Riverside (Corps of Engineers implementation with a non-Federal sponsor).

- A flood diversion channel from Horace to West Fargo (Corps of Engineers implementation with a non-Federal sponsor).

- A 5-foot raise of Baldhill Dam to provide additional flood control storage (Corps of Engineers implementation with a non-Federal sponsor).

• Ring levees or other individualized flood proofing at flood-prone farmsteads and residences (non-Federal or other Federal agency implementation or continued evaluation for potential Corps of Engineers implementation).

• A multiple-purpose dam for flood control and recreation on Dead Colt Creek, a tributary of the Sheyenne River (non-Federal implementation).

• Increase in the storage capacity of wetlands (drained and existing) to retain floodwaters (non-Federal or other Federal agency implementation).

The General Reevaluation and Environmental Impact Statement consists of four volumes: the main report and environmental impact statement (published jointly in one volume) and three volumes of technical appendixes.

The main report summarizes the water resource and related problems and needs of the basin, the alternatives evaluated, the process used to develop and select a plan, the conclusions of the study, and the recommendations for Federal participation through the Corps of Engineers.

The enviromnental impact statement, bound with the main report, describes the environmental effects of implementation of the selected plan and discusses the relative merits of the other alternatives.

The technical appendixes present the detailed information used in investigating the problems and needs, assessing the impacts of the alternatives, and evaluating the alternatives and technical details of the selected plan.

These "General Reevaluation" studies were accomplished under the title of "Phase I General Design Memorandum" during the period 1976 through February 1982. Any references in these general reevaluation documents to "Phase I General Design Memorandum" is synonomus with a reference to a "general reevaluation".

Comments or inquiries on the General Reevaluation and Environmental Impact Statement should be sent to:

District Engineer
St. Paul District, Corps of Engineers
ATTN: NCSPD-PF
1135 U. S. Post Office & Custom House
St. Paul, Minnesota 55101

APPENDIX D

ENVIRONMENTAL RESOURCES

GENERAL REEVALUATION

AND

ENVIRONMENTAL IMPACT STATEMENT

SHEYENNE RIVER, NORTH DAKOTA

AUGUST 1982

APPENDIX D

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INTRODUCTION

This appendix is divided into 10 sections. Described in these sections are:

- The existing natural resources of the basin, including vegetation, wildlife, fish, aesthetics, and other environmental features.

- Anticipated future conditions related to clearing of woodlands, draining of wetlands, planting of vegetation, and so on.

- Fish and wildlife objectives for the basin developed by comparing existing and anticipated conditions through discussions with natural resource agencies and citizens committee input.

- A list of the alternatives that address the fish and wildlife objectives and that would help solve the problems and needs associated with the basin's natural resources.

- The importance of riparian and wetland habitat to fish and wildlife.

- The timber resources of the Sheyenne River basin

- The vegetation/groundwater level relationships in the Sheyenne delta area near Kindred, North Dakota.

- The effects of flooding and temporary inundation on vegetation and wildlife habitat.

- The vegetation management plan for the diversion channels.

- Endangered species coordination.

In addition to developing flood control alternatives, the goal of the planning process is to identify plans that enhance or preserve the natural resources of the basin. Measures addressing alternative resource uses should receive consideration even if the Corps cannot implement them. The intent is to formulate plans that best address planning objectives in the overall public interest to achieve desired outputs. The natural resources of the basin belong to everybody, and they should be preserved or enhanced whenever possible.

Input received at the public workshop in June 1977 and subsequent citizens committee meetings have indicated that fish and wildlife resources are important and should be considered in water resource development planning for the basin. The Corps planning process recognizes that the preservation of natural resources and the selection of alternatives to solve the resource needs of the basin have local support.

The environmental impacts of the flood damage reduction alternatives are discussed in Appendix L, Flood Damage Reduction Alternatives, and Appendix M, Plan Formulation. The U.S. Fish and Wildlife Service's Coordination Act Report is in Appendix N.

EXISTING ENVIRONMENTAL SETTING[1]

The Sheyenne River drainage area encompasses 10,720 square miles, including the 3,580-square-mile Devils Lake basin which is considered noncontributing. The elevation at the river's mouth is about 850 feet above mean sea level. The river is about 550 miles long, with an average slope of about 1.5 feet per mile on the drift prairie, about 2 feet per mile as it enters the Red River Valley, and about 1 foot per mile in the glacial Lake Agassiz basin. The three main tributaries of the Sheyenne River are Baldhill Creek, Maple River, and Rush River, with drainage areas of 740, 1,560, and 240 square miles, respectively. The only major impoundment in the Sheyenne River basin is Lake Ashtabula, formed by Baldhill Dam. The lake is a multipurpose reservoir with most of its benefits attributed to downstream water supply. Many smaller impoundments in the basin are used primarily for stock watering, municipal supplies, and recreation.

The Sheyenne River is the largest river lying completely within North Dakota. Three distinct physiographic areas constitute the Sheyenne River basin: the Red River Valley (glacial Lake Agassiz), the Sheyenne delta sandhills, and the drift prairie. Most of the basin lies within the drift prairie area, which is characterized by gently rolling to hilly topography. The river runs through the drift prairie from its source in Sheridan County to about 9 miles southeast of Lisbon in Ransom County.

---

(1)Much of the information in this section on vegetation, wildlife, fisheries, and water quality is summarized from Barker et al., 1977, Environmental Inventory of the Existing Setting in the Sheyenne River Basin, North Dakota, prepared by the Tri College University, Center for Environmental Studies, Fargo, North Dakota, under contract with the St. Paul District, Corps of Engineers. The entire report is on file at the St. Paul District.

The sandhills area was formed from the delta deposited by the Sheyenne River as it flowed into former glacial Lake Agassiz. This area is characterized by old high sand dunes interspersed with areas of gently rolling or level topography. Most of the area is stabilized with vegetation, but a few localized blowouts are present. The river valley is heavily wooded in this region. The Sheyenne River flows through the sandhills area from approximately 9 miles southeast of Lisbon in Ransom County to about 4 miles southwest of Kindred in Richland County.

The Red River Valley is a very flat area which is the bed of glacial Lake Agassiz. There is virtually no topographic relief in this area, which is predominantly agricultural with some terrestrial vegetation along the riverbank. The Sheyenne River flows through the area from about 4 miles southwest of Kindred in Richland County to the point where it empties into the Red River, just north of Harwood in Cass County.

LAND USE

The Sheyenne River basin occupies an area of more than 3 million acres. The predominant land use in the basin is agricultural, with over 70 percent of the area in cropland. Various land use proportions in the area are shown in Appendix F.

VEGETATION

Today, only 1 percent of North Dakota is classified as woodland. Prior to the 1940's, there were about 600,000 acres of woodland in North Dakota; now there are about 400,000 acres. Much of this loss has resulted from the construction of the Missouri River reservoirs, land clearing for agriculture, the construction of other reservoirs, and various land use changes, such as residential development. The existing wooded area is a valuable wildlife resource and is important as a refuge for rare or uncommon plant and animal species.

The Sheyenne River basin, with 1 percent woodland, has more wooded area than many other North Dakota basins, both in terms of percentage and total acreage. In addition, it is important that some of this woodland is present in large contiguous areas. For example, 56 percent of the basin's commercial woodland is in Barnes, Richland, and Ransom Counties. This point demonstrates the scarcity and importance of woodland in North Dakota. Table D-1 presents a comparison of the amounts of woodland in various river basins in North Dakota.

Table D-1 Amount of woodland in various North Dakota river basins

River basin	Amount of woodland (acres)	Percent of basin wooded
Pembina	74,000	6
Sheyenne	38,000	1
Red (main stem)	12,000	1
Missouri (main stem)	3,000	0.1
James	3,500	0.1
Maple	3,000	0.3
Goose	5,000	0.7
Wild Rice	2,000	0.2
Pipestem	0	0

Some areas of valuable vegetation and wildlife habitat have been preserved in the Sheyenne River basin. Two areas around Lake Ashtabula are the Baldhill Wildlife Refuge (about 600 acres) and the Baldhill Game Management Area (about 900 acres). In other portions of the lower basin, the Fort Ransom State Park (about 600 acres), Sheyenne State Forest (about 508 acres) and Mirror Pools Game Management Area (about 508 acres) protect important wildlife habitat. In addition, the Sheyenne National Grasslands (about 70,000 acres) provides significant wildlife value along with its primary use of domestic livestock grazing.

The vegetation of the Sheyenne River basin is very diverse and includes many plants that are uncommon in North Dakota. Because of its relatively large expanses of woodland, its geographic location, and its microclimatic characteristics, this section of North Dakota is able to support species of plants that otherwise occur more commonly in western North Dakota or farther east in Minnesota. Eastern deciduous woodland species and western prairie species meet in the lower basin. Table D-2 shows the number of sightings of rare plants in various portions of the basin.

Table D-2 Sightings of rare plants in the Sheyenne River basin

Reach	Number of sightings
Between Kindred and the mouth	2
Between Kindred and Lisbon	27
Between Lisbon and Valley City	4
Between Valley City and Burlington Northern railway bridge	2
Between Burlington Northern railway bridge and headwaters	0

The primarily east-west orientation of the rivers in the area accounts for the presence of many of these rare species. The rivers have served as migration routes for eastern deciduous woodland species. Another reason for the diversity of vegetation is the large areas of woodland in the lower basin which provide favorable habitat and make it possible for these species to survive.

Some of the uncommon plants in the basin are: showy lady-slipper (Cypripedium reginae), prairie fringed orchid (Habenaria leucophaea), rhombic evening primrose (Oenothera rhombipetala), bog bedstraw (Galium labradoricum), burning bush (Eunoymus atropurpureus), and Indian pipe (Monotropa uniflora). The lower basin is near the western limits of a number of rare plant species. For example, basswood (Tilia americana) attains very large size around Anselm but is found only as scattered individuals farther upstream because of unfavorable soil and moisture conditions. Two other rare species are paper birch (Betula papyrifera) and ironwood (Ostrya virginiana).

Other rare plant species found in the basin include: Equisetum palustris, Athyrium filix-femina, Dryopteris cristata, D. spinulosa, Onoclea sensibilis, Ranunculus recurvatus, Pilea fontana, Sicyos angulatus, Apios americana, Menyanthes trifoliata, Campanula aparinoides, Potamogeton filiformis and Cyperus rivularis. The number of rare species found in the area is indicative of the value and uniqueness of the basin.

A comparison of the flora in the Sheyenne and James River basins reveals that the Sheyenne River basin has 60 species of plants not found in the James River basin just 50 miles to the west. Most of these differences can be accounted for by the direction of flow of the two rivers. The James River flows south to the Missouri River, while the Sheyenne River flows east to the Red River (the significance of this factor was discussed above). This comparison points out some of the unique qualities of the Sheyenne River valley.

FISH

The Sheyenne River has many types of fish, with over 50 of the approximately 80 species recorded for the entire Red River drainage area in Minnesota and North Dakota. Yet the Sheyenne River basin is only 24 percent of the Red River basin. The Sheyenne River is also reported to have three species of mollusks, more than any river in the State. Table D-3 compares the number of fish species found in various rivers in North Dakota.

Table D-3 Comparison of fish species in North Dakota rivers and lakes

River or lake	Number of fish species
Sheyenne River	53
Upstream of Baldhill Dam	(31)
Downstream of Baldhill Dam	(49)
Pembina[(1)]	27
Forest[(1)]	26
Wild Rice[(1)]	12
Goose[(1)]	24
Maple[(2)]	21
Rush[(2)]	14
Souris	45
Lake Sakakawea	48

(1) Denotes Red River tributary.
(2) Denotes Sheyenne River tributary.

The important aspect to note in Table D-3 is that the Sheyenne River has twice as many species of fish as the other Red River tributaries. Some of the fish in the Sheyenne River include bass (*Micropterus* sp.), channel catfish (*Ictalurus punctatus*), redhorse (*Moxostoma* sp.), crappie (*Pomoxis* sp.), sunfish (*Lepomis* sp.), and bullhead (*Ictalurus* sp.). The large number and diversity of fish species in the Sheyenne River result from the variety of habitats and substrates present. The woodlands along the river provide shade, organic detritus, and debris for fish habitat. In addition, most of the river is in glacial till containing pools and gravel riffles which provide a great diversity of habitats for aquatic organisms. Most of the other North Dakota tributaries of the Red River lie within the boundaries of glacial Lake Agassiz where the substrate (silt and clay) does not offer much variety in habitats. Other factors may be important downstream from Baldhill Dam:

a. The constant flow of water and the additional flow of groundwater into the Sheyenne River from the Sheyenne River delta prevent depletion of dissolved oxygen during low-flow periods.

b. The many small spring-fed streams in the Sheyenne River delta may provide unique clean-water conditions required for certain fish. The cool, spring-fed streams in the delta area are unique areas for forage fish. In 1977, the blacknose shiner (Notropis heterolepis) was found in these springs for the first time since 1929. The rosyface shiner (Notropis rubellus) and greater redhorse (Moxostoma valenciennesi) are peripheral species that are found in the Sheyenne River basin. Other uncommon species, such as the blacknose dace (Rhinichthys atratulus) and the northern redbelly dace (Chrosomsicos sp.) are also found in the springs and pools. The occurrence of these species is a good indication that the springs are functioning as refuge areas.

A potential fish spawning area with additional aesthetic qualities is the Mirror Pools Game Management Area, an approximately 500-acre area of spring-fed streams and pools that could be used as a cold-water trout hatchery. This type of area is very uncommon in the basin and in North Dakota in general. Another 15-acre area of spring-fed streams is near Warwick; springs are not common elsewhere in the State.

The Sheyenne River and Lake Ashtabula are important recreational fishing resources. The estimated number of man-days of fishing in Lake Ashtabula in 1974 and 1975 was about 4 to 6 times that in the Sheyenne River. The angler effort in the Sheyenne River was 15 percent of the total angler effort in river fishing in the State. In 1974, about 1.1 percent of the estimated 1,511,000 man-days of fishing in North Dakota was spent on the Sheyenne River. In 1975, about 0.6 percent of the estimated 1,383,000 man-days occurred on the Sheyenne River. Corresponding values for Lake Ashtabula were 6.3 percent and 2.5 percent in 1974 and 1975, respectively. Table D-4 summarizes sport fishing in Lake Ashtabula and the Sheyenne River for 1969, 1970, 1971, 1974, and 1975.

Table D-4 Summary of sport fishing in Lake Ashtabula and the Sheyenne River (1)

Item	1969 (2)	1970 (2)	1971 (3)	1974 (4)	1975 (4)
Lake Ashtabula					
Man-days	52,338	24,687	18,661 (5)	95,028	34,626
Number of fish caugh	162,248	54,805	137,832 (6)	715,035	458,206
Number of fish/man-day	3	2	7	8	13
Expenditures ($)	-	-	-	1,784,608	646,030
Sheyenne River					
Man-days	-	-	-	16,770	7,836
Number of fish caught	-	-	-	66,778	33,060
Number of fish/man-day	-	-	-	4	4
Expenditures ($)	-	-	-	626,080	293,664

(1) From Barker et al., 1977.
(2) Duerre, 1972.
(3) Owen and Ruehle, 1972.
(4) Duerre, 1977, personal communication.
(5) Estimated from data of Owen and Ruehle, 1972, using 6.6 hours for the average time per angler trip as reported by Duerre, 1972, for 1969 and 1970.
(6) Estimated weight of fish caught was 37,121 kilograms (81,668 pounds).

Lake Ashtabula provides a fair to good fishery for northern pike, walleye, white bass, perch, white sucker, and black bullhead. Northern pike and walleye account for approximately 10 percent of the total angler harvest. In 1975 and 1976, northern pike and walleye constituted 5.3 percent and 4.2 percent, respectively, of the total State harvest for those two species. Populations of these species are highly dependent on stocking from the Valley City Federal Fish Hatchery. Carp are absent from Lake Ashtabula and the upper watershed.

While the walleye and northern pike offer a fair sport fishery, yellow perch and black bullhead are the dominant species harvested. Since 1953, Lake Ashtabula has supported a sporadic commercial fishery for black bullhead, white sucker, and yellow perch. Total catches harvested thus far are 2,742,073 pounds, 63,816 pounds, and 103,719 pounds, respectively.

The average angler use per year from 1969 to 1975 was 45,068. The 100-year mean for Lake Ashtabula is projected to be approximately 28,000 angler days per year. During a 2-year period (1974-1975), an average of 64,827 angler days per year were recorded for Lake Ashtabula. This amounted to an average annual expenditure of $1,215,300 or approximately $18.50 per angler day.

Fishing success averages about 10 fish per man-day in Lake Ashtabula and about 4 fish per man-day in the Sheyenne River. Approximately 15 percent of the fish caught in the Sheyenne River in 1974 and 1975 were northern pike and walleye. In Lake Ashtabula, approximately 11 percent of the catch in 1974 and 3 percent of the catch in 1975 were northern pike and walleye.

Low-head dams along the Sheyenne River (Valley City, Kathryn, Fort Ransom, Lisbon, and West Fargo) undoubtedly are barriers to the upstream movement of fish, especially during low water periods. Recent surveys reveal that the greatest number of fish species at any station along the river was recorded below the Lisbon Dam. These low-head dams are also the places where a majority of the fishing takes place.

Walleye and northern pike are two of the more commonly sought fish in the lower Sheyenne River. Yellow perch, bullheads, smallmouth bass, channel catfish, and white sucker also contribute to the stream fishery. Yellow perch and bullheads, however, make up a major portion of the catch. Carp are common in the downstream area. Upstream movement of fish from the Red River may be important in providing fish to the Sheyenne River. In addition, the Sheyenne River provides forage fish, reproductive sites, and nursery areas for species which normally spend their adult lives in the Red River.

During a 2-year period (1974-75) an average of 12,303 angler days per year was recorded for the lower Sheyenne River. This amounted to an average expenditure of $409,800 annually.

An important factor affecting fish and other aquatic organisms in the Sheyenne River is the rate of flow, which helps maintain dissolved oxygen concentrations. Fluctuations in discharge in the Sheyenne River appear to influence relative and absolute abundance of fishes and mollusks.

WILDLIFE

Because of its diverse and relatively abundant vegetation, the Sheyenne River basin contains many species of wildlife. Certain areas in the basin are essential to the continued high productivity and healthy populations of wildlife. Some areas of the basin also provide habitat for locally rare species.

The most valuable wildlife habitat in the basin is provided by the existing wetlands, woodlands, and grasslands which are relatively scarce or have regional and national importance. The relatively large block of woodland in the Anselm to Kindred area is very valuable wildlife habitat. The wooded corridor along the river provides a route for wildlife movement between larger stands of woodland. Although specific population levels are not available for the Sheyenne River basin, it is still possible to obtain some general population estimates from the literature. Leitch (1975) evaluated the value of wildlife in the Sheyenne River basin. Table D-5 presents population levels from that study.

Table D-5
General estimates of wildlife population levels in the Sheyenne River basin (Pop./Mi.2)[1][2]

Species (habitat)	Region: Lake Agassiz	Sheyenne Delta	Drift Prairie
Deer (woodland)	.47	7.1	1.7
Pheasant (cropland edge)	.94	7.1	1.5
Hungarian partridge (cropland shelterbelt)	4.7	4.7	.99
Sharp-tailed grouse (grassland)	.24	.94	.11
Tree squirrel (woodland)	9.46	18.89	2.98
Fox (cropland)	.30	1.0	.6
Raccoon (wetland)	.71	2.4	.74
Muskrat (wetland)	1.42	4.7	1.5

(1) From Leitch, J. 1975. Application of Five Methods for Measurement of Wildlife Value: Lower Sheyenne River Basin, North Dakota. Thesis. North Dakota State University,

(2) Based on total land area in these regions.

The State of North Dakota also prepares population density maps for selected wildlife species. Population estimates from these maps are presented in table D-6.

Table D-6
Population estimates from North Dakota Game and Fish Department species maps[1]

Species	Population
Waterfowl	4-9 breeding pairs per square mile
Deer	More than 1.5 per square mile
Red fox	9-13 families per township
Hungarian partridge	Less than 12 birds per 1,000 miles
Sharp-tailed grouse	Less than 3 per square mile
Pheasants	Sandhills area - more than 10 hens per square mile
	Lake Ashtabula - 1 to 10 hens per square mile

(1) Source: North Dakota Game and Fish Department.

As mentioned earlier, there are few studies available on specific wildlife species. The one exception is white-tailed deer. Challey (1955) studied the white-tailed deer in the Sheyenne sandhills and found populations ranging from 6.6 to 9.4 deer per square mile. Other studies have shown that riparian forests in riverbottoms along the Sheyenne River provide a considerable amount of cover in winter (Barker et al., 1977). Plates D-1 through D-5 contain maps showing various wildlife population densities in North Dakota.

Mammals

Recent mammalogical data (distribution, abundance, etc.) are generally lacking in the State of North Dakota and are scattered among the colleges, universities, and various State agencies. Most of the available information concerns hunted species; little information has been collected on nongame species. At present, approximately 73 species of mammals occur in the State. Of these, 56 are believed to be found in the Sheyenne River basin. Most of the species are year-round residents, but some of the bats probably migrate. Some of the more common species found in the basin include eastern cottontail (Sylvilagus floridanus), squirrels (Sciurus sp.), beaver (Castor canadensis), red fox (Vulpes vulpes), mink (Mustela vison), and white-tailed deer (Odocoileus virginianus).

A summary of information on some of the major species in the basin is presented here. This material has been drawn from North Dakota Game and Fish Department records and from other available literature.

Beaver density in the lower Sheyenne River basin has been fairly high over the last several years and higher than in the upper basin. Mink densities are highest in the drift prairie area of the upper basin and have been stable over the last 5 years. White-tailed deer are common from Devils Lake to Horace. Densities of this deer, the main big game animal in the Sheyenne River basin, are among the highest in the State. The gallery forest along the river and the eastern deciduous forest in the sandhills area provide the best type of deer habitat in the eastern part of the State. In addition, deer rely on deciduous woodlands for winter cover.

During the severe winter of 1977-1978, the woodlands between Kindred and Fort Ransom supported a 40-percent increase in the wintering deer herd over the preceding year, as reported by winter aerial surveys. Deer sought out these valuable woodlands for food and cover during the extreme winter. The basin supports the highest hunter harvest of deer in the State. Table D-7 summarizes some of the harvest data.

Table D-7 White-tailed deer harvest summary (1952-1971)

Area	Number of hunters	Hunters per 1,000 square miles	White-tailed deer harvest: Total number	White-tailed deer harvest: Number per 1,000 square miles
State	39,903	576	21,008	323
Headwaters region	2,374	457	1,446	285
Devils Lake area	513	544	309	336
Sheyenne to Cooperstown	1,110	815	703	521
Cooperstown to Valley City	887	452	582	303
Valley City to Highway 46	384	429	241	274
Highway 46 to Highway 18	1,243	651	703	391

The red fox is a highly sought after furbearer and populations in the Sheyenne River area are among the highest in the State. Trapping for red fox and coyote is very popular in the area. Harvest data for fox for selected counties in the Sheyenne River basin are presented in table D-8.

Table D-8 Hunter harvest data for red fox

County	1973-74	1974-75	1975-76
Barnes	993	380	678
Cass	1,481	568	945
Griggs	473	181	328
Ransom	560	215	388
Richland	689	264	450

Birds

Of the 339 bird species on the current checklist of birds occurring in North Dakota, 262 (77 percent) occur in the Sheyenne River basin. Some species in the basin include white pelican, double-crested cormorant, herons, geese, hawks, pheasant, grouse, prairie chicken,

owls, woodpeckers, ducks, and a variety of nongame species. The National Audubon Society has prepared a "Blue List" which notes species of North American birds that have suffered recent population declines and deserve special attention. Some species on this list include white pelican, double-crested cormorant, canvasback, Cooper's hawk, osprey, burrowing owl, redheaded woodpecker, and others.

The white pelican does not breed in the Sheyenne River basin, but some individuals from Stutsman County wander into the basin and can be found on Lake Ashtabula and downstream. The double-crested cormorant is concentrated near Lake Sakakawea. Some colonies have been seen in the Sheyenne River basin. The wood duck, which was near extinction around the first part of the 20th century, is now beginning to stage a comeback and is fairly common along the lower Sheyenne River where it is associated with gallery forests. It is also fairly common along the Red River, Wild Rice River, and portions of the James River. It is uncommon elsewhere within the Agassiz lake plain region.

The Cooper's hawk is fairly common in the Turtle Mountains and Pembina Hills and along the Sheyenne River in Griggs, Barnes, and Ransom Counties. It is uncommon to rare elsewhere in the State.

The prairie chicken is a very rare species in North Dakota. Its preferred habitat, at least for booming grounds, is grassland. This bird is restricted to the sandhills-grassland area where it is associated with the sharp-tailed grouse. About 95 percent of the State's population of prairie chickens (300 of 320) is in the Sheyenne National Grasslands. The others are near Oaks and Grand Forks.

The whooping crane, a federally listed endangered species, formerly nested in North Dakota. Today they nest only in a small colony in northern Alberta. This flock usually passes through the Sheyenne River basin on its annual spring and fall migration, using the wetlands along the way. The pileated woodpecker is not common in North Dakota and occurs only along the Red and Sheyenne Rivers in Cass, Richland, and Ransom Counties.

The rare plant communities and woodlands of the lower basin provide an isolated habitat niche which sustains a unique population of birds and mammals. At least two species of birds that nest in the lower basin are not known to occur elsewhere in North Dakota: the barred owl and the cerulean warbler. In addition, several other rare or uncommon birds nest in the lower Sheyenne River basin: the scarlet tanager, yellow-billed cuckoo, yellow-bellied sapsucker, pileated woodpecker, yellow-throated vireo, green heron, and American woodcock.

Amphibians and Reptiles

Eleven species of amphibians are known to occur in North Dakota, nine of them in the Sheyenne River basin. Compared to other areas of the country, North Dakota has very few types of amphibians. This results in part from low temperatures and precipitation. Amphibian species are present all year but are only visible in the warm months of the year because they hibernate during cold weather. Some of the species present include the tiger salamander (*Ambystoma tigrinum*), great plains toad (*Bufo cognatus*), gray tree frog (*Hyla versicolor*), and wood frog (*Rana sylvatica*). Both the gray tree frog and the wood frog are found in the eastern part of the State and appear to be restricted to gallery forests. The prairie skink is restricted to the southeastern part of the State, and is not found beyond southern Barnes County.

Of the 14 species of reptiles known to occur in North Dakota, 8 occur in the Sheyenne River basin. In contrast, Minnesota has 27 and South Dakota has 28 species of reptiles. Some of the reptiles are snapping turtle (*Chelydra serpentina*), plains garter snake (*Thamnophus indix*), and smooth green snake (*Opheodrys vernalis*).

Endangered and Threatened Species

Three species of birds on the Federal Endangered and Threatened Species List - the bald eagle, whooping crane, and peregrine falcon - could occur in the project area although they would probably only be migrating through the area.

The Sheyenne River basin has no mammals, reptiles, or amphibians on the Federal list. Although an eastern timber wolf was killed in the Sheyenne National Grasslands in 1972, this was a rare occurrence and the individual was outside its normal range.

One species of insect, the Dakota skipper butterfly (Hisperia dacotae) is considered to be rare in the State. Another rare species found in the Kindred project area is the straight-snouted weevil (Platysystrophus minutus) (Wildlife Society, 1978).

There are a number of species of plants, birds, and wildlife that are considered rare, threatened, or endangered on the State level (Barker, et al., 1977). These species have been discussed in other portions of this report.

Wildlife Harvests

Each year, the North Dakota Game and Fish Department mails questionnaires to selected hunters and trappers in the State. They ask questions pertaining to the number of outings, game harvest, area hunted, expenditures, etc. The responses are collated and summarized on a county-by-county basis. The figures are then computerized and can be retrieved either on a yearly basis or as an average value for the period of record. The figures presented here are for a 6-year period (1970-1975).

Describing the lower Sheyenne River study area posed a difficult problem. The information was collected by county rather than by specific drainage area. Thus, the percentage of the harvest occurring in the Sheyenne River basin had to be determined from this information. Minimum, maximum, and average values for the man-days and harvest were established. A percentage of the total county harvest, which could be attributed to the basin, was assigned. The minimum figure was about 36 percent (one-third of the total), the average value was 50 percent (one-half of the total), and the maximum value was 67 percent (two-thirds of the total). Then, each individual species was examined to determine its habitat needs and where in the county those needs could best be satisfied. For example, gray and fox squirrels require a mature forest for optimal conditions. This type of habitat is found along the Sheyenne River and is likely to be where the squirrels are found. However, some squirrels are harvested in the shelterbelts and small woodlots throughout the county. It would not be valid, therefore, to assume that 100 percent of the countywide harvest occurred in the Sheyenne River basin. In this case, about two-thirds of the harvest was estimated to have occurred in the basin. It should be noted that the figures are preliminary and pertain only to the lower Sheyenne River basin portions of Barnes, Ransom, and Richland Counties. An example of this harvest data is presented in table D-9.

A monetary evaluation of the wildlife resources in the Sheyenne basin was conducted to assess the value of the hunting and to give an indication of the resource value in the Kindred Dam and Lake Ashtabula areas. Two methods were used to determine the value of hunting: the travel-cost and unit-day methods. The travel-cost method is based on the relationship between distance to and demand at the site. This method yielded an annual hunting value of $1,356,000 at the Kindred site and $723,000 at the Lake Ashtabula site. The other method used to estimate hunting value was the unit-day method which utilizes the number of days spent hunting and a dollar estimate for the value of one day of hunting. The method resulted in a range of values of $341,000 to $1,550,000 per year for the Kindred Dam site and $170,000 to $1,015,000 per year for the Lake Ashtabula site. These figures are an estimate of the value of the hunting resource. (For a more detailed discussion of both of these methods, see Appendix I, Recreation).

Table D-9 Gray partridge harvest and man-days of use in selected counties of the Sheyenne River basin(1)

	1970	1971	1972	1973	1974	1975	County
Harvest	3402	1654	2477	2923	1034	459	Barnes
Man-days	2187	2031	2673	3030	943	469	
Harvest	794	1018	1831	3050	3147	1390	Cass
Man-days	1640	1250	1976	3162	2870	1419	
Harvest	1928	2544	646	508	827	791	Eddy
Man-days	1312	3125	697	527	757	807	
Harvest	794	891	2800	1017	709	485	Griggs
Man-days	765	1094	3022	1054	647	495	
Harvest	1587	890	1077	1144	3073	2805	Nelson
Man-days	1640	1094	1162	1186	2803	2864	
Harvest	567	636	215	127	458	1492	Ransom
Man-days	765	781	232	132	418	1523	
Harvest	113	1272	754	1144	5230	1198	Richland
Man-days	219	1562	814	1186	4771	1224	
Harvest	1701	3562	4092	2160	1684	1925	Wells
Man-days	1421	4374	4416	2240	1536	1966	

(1) Barker et al., 1977. Tri College University, Center for Environmental Studies. Environmental Inventory of the Existing Setting in the Sheyenne River Basin, North Dakota. Fargo, North Dakota. On file at St. Paul District.

WATER QUALITY

The water quality of the Sheyenne River is relatively poor and is directly related to land use in the basin; i.e., primarily cropland and secondarily pastureland (more than 140 feedlots are located near the river). In addition, 700 to 800 homes located along the river are not served by municipal sewage treatment facilities. Most of the eight cities located along the river are currently improving their treatment facilities. In many cases, the improvement consists of providing a lagoon in place of direct discharge into the river. The bacteriological quality of the river is very poor, as evidenced by the presence of coliforms of fecal origin and intestinal pathogens of both man and domestic animals. Ammonia and bacteria levels in the river are high.

Lake Ashtabula is eutrophic, with high nutrient levels and frequent algal blooms. This condition reduces the fishery, recreational, and aesthetic qualities of the reservoir. Although phosphorous levels are about eight times the level that causes eutrophication, nitrogen is the cause of the eutrophic conditions in Lake Ashtabula and probably also in the Sheyenne River (Barker et al., 1977). (See Appendix J, Water Quality, for a more detailed discussion of the existing water quality and water quality problems in the basin.)

PRIME AND UNIQUE FARMLANDS

Part of the national inventory of prime and unique farmland was conducted in North Dakota by the Soil Conservation Service. Prime farmland is defined as land which is best suited for producing food, feed, forage, fiber, and oilseed crops and which is available for these uses. For example, such land could be cropland, pasture, range, forestland, or other types, but not built-up urban land. Prime farmland has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed in accordance with modern farming methods. Plates D-6 through D-9 show the locations of the general prime farmland (based on general soils maps) in the Sheyenne River basin (from North Dakota Public Service Commission, Inventory Maps of Exclusion and Avoidance Areas for the Location of Energy Conversion Facilities).

Unique farmland is defined as land other than prime farmland which is used to produce specific high-value food and fiber crops. The Sheyenne River basin has no unique farmland.

Appendix F contains further discussion of agricultural land uses.

U.S. FISH AND WILDLIFE SERVICE WETLAND EASEMENT PROGRAM

The U.S. Fish and Wildlife Service conserves North Dakota wetlands by purchase or easement through the Small Wetlands Program. These efforts are financed through the sale of duck stamps. Many wetlands have been preserved by purchase of easements from landowners who agree not to drain, burn, or fill wetlands on their property. Farming of the land continues, but the wetlands are protected. Plates D-10 through D-13 show the locations of wetland easement areas in the Sheyenne River basin (from North Dakota Public Service Commission, Inventory Maps of Exclusion and Avoidance Areas for the Location of Energy Conversion Facilities).

WILD AND SCENIC RIVERS

The Sheyenne River from Horace in Cass County to Valley City in Barnes County (excluding a short stretch at Lisbon) had been identified as a category 2 river ("Nationwide Rivers Inventory" prepared by the Heritage Conservation and Recreation Service in May 1978). Category 2 rivers are defined as rivers meeting minimum qualification standards for inclusion in the National Wild and Scenic River System; however, the most recent listing, dated January 1982, does not include the Sheyenne River. The river is therefore no longer classified as a category 2 river, and future inclusion in the system seems doubtful. (For additional information see Appendix I, Recreation.)

AESTHETICS

The Corps of Engineers has recognized, as evidenced by ER 1165-2-2, the need to consider both economic and aesthetic consequences of its recommendations and actions.

Aesthetic evaluations are based, for the most part, upon qualitative judgment. It is difficult to measure directly the value of the seen environment. Attaching a dollar value, as required by the benefit-cost ratio, is even more difficult. It is, however, generally agreed that beauty does have economic implications as is evidenced by the large number of people visiting our national parks.

To date, the Corps has not developed its own method for visual resource evaluation. Therefore, the following discussion incorporates evaluation criteria developed by the U.S. Department of Agriculture, Forest Service.

Visual resource evaluation deals with those aspects of the environment that are perceived by the sense of sight. The following criteria used in Forest Service visual resource evaluation studies will be incorporated in this report.

1. A particular geographic region tends to have an identifiable image.

2. The visual impacts of an area increase as the duration of the view increases beyond a quick glance.

3. All landscapes have a definable character, and those with the greatest variety or diversity have the greatest potential for high scenic value.

4. Landscapes with distinctly natural variety in form, line, color, and texture should be retained and perpetuated.

5. Each landscape unit has its individual capacity to accept alteration without losing its inherent visual character.

6. The visual impact increases as the modification elements deviate from elements inherent in the natural landscape.

7. Landscapes with little or no variety may be enhanced by alteration.

8. An increase in viewing distance decreases the visual impact.

9. Visual impact increases as the viewer's focus and attention increase.

10. Visual impact increases as the viewer's line of sight becomes more perpendicular to the slope.

The following method used to evaluate flood control alternatives on the Sheyenne River documents the base-line data necessary to meet these criteria.

As pointed out by the American Society of Landscape Architects in its Technical Information Series, Volume 1: No. 2, simplicity is a virtue. Overly complex land evaluation systems usually gather dust on someone's shelf. A simple system, easily initiated, can be perfected and expanded over time.

The first step, adapted from the U.S. Forest Service, is to identify common, distinguishing visual characteristics in the area affected by the project (i.e., land forms, rock formations, water forms, and vegetative patterns). This area or areas will be called a character type.

The second step, in case the character type is too broad to provide a logical frame of reference, is to establish subtypes. Subtypes are divisions of the major character type that are significantly different in visual characteristics.

After identifying the characteristic landscape, the third step is to assign a classification rating to the seen environment:

1. Class A - Distinctive.
2. Class B - Common.
3. Class C - Minimal.

Assigning a distinctive, common, or minimal classification to the landscape documents the qualitative value. Variety classes are based on comparisons between physical features commonly found in the character type. Ranking the class B features within the area is done first to establish a bench mark from which distinctive and minimal classifications can be judged.

Assigning sensitivity levels is step 4. Sensitivity levels refer to people's concern for the seen environment. Three sensitivity levels are employed to identify different levels of concern:

1. Level 1 - Highest sensitivity.
2. Level 2 - Average sensitivity.
3. Level 3 - Lowest sensitivity.

Again, as in the previous steps, the objective is to document an assigned qualitative value. The criteria used to evaluate sensitivity levels are based on distance zones. Distance zones are divisions of a particular landscape being viewed. The three distance zones are foreground, middle ground, and background. Sensitivity levels, as they relate to distance zoning, should be determined on a case-by-case basis. The following guidelines are used in identifying distance zones:

1. Foreground - 1/4 to 1/2 mile.
2. Middle ground - Foreground to 3 to 5 miles.
3. Background - Middle ground to infinity.

The final step in the aesthetic evaluation process is to describe the potential positive and negative effects of each alternative. Completion of steps 1 through 4 will provide the base data necessary to evaluate this last step. Examples of the positive and negative descriptions might be as follows:

Example 1: It is generally agreed that the existence of vegetation can be considered a positive effect in any setting in which it does not form the characteristic landscape. Channelization is one flood control measure that destroys riparian vegetation. The loss of riparian vegetation in an agricultural landscape would be considered a negative effect.

Example 2: Permanent reservoirs are also used to control flood-prone areas. Permanent, flat water bodies are generally considered to have a positive effect in any area. They do not form the characteristic landscape. However, final decisions should be made on a case-by-case basis. Other factors must be considered, such as the loss of a natural river or the inundation of agricultural land.

The following description of the existing aesthetic qualities employs the above procedure.

Kindred Dam Area

1.	Character type	- Intensely cultivated, rolling pothole region.
2.	Character subtype	- Heavy riparian vegetation along meandering river system in oxbow development stage.
3.	Classification	- Class A - distinctive.
4.	Sensitivity[1]	- Affects all three levels.

(1) Based on distance from major highway(s).

Levees and Diversion/West Fargo

1. Character type - Level, intensively cultivated region.
2. Character subtype - Meandering, sparsely vegetated stream.
3. Classification - Class B - common.
4. Sensitivity(1) - Mostly occurring in levels 1 and 2.

Baldhill Dam Area

1. Character type - Intensively cultivated, rolling, pothole region.
2. Character subtype - Flat, irregularly shaped body of water with sparse vegetation along shoreline.
3. Classification - Class A - distinctive.
4. Sensitivity(1) - Affects all three levels.

Diversions to Wild Rice River

1. Character type - Intensively cultivated, flat, pothole landscape.
2. Character subtype - None.
3. Classification - Class C - minimal.
4. Sensitivity(1) - Level 3 - lowest sensitivity.

Diversion - M-65

Character type, subtype, and classification are the same as those used for diversions to Wild Rice River.

4. Sensitivity - Level 1 - highest sensitivity.

Channelization - Sheyenne River - Kindred to Mouth

1. Character type - Intensively cultivated, rolling, pothole landscape.
2. Character subtype - Heavy riparian vegetation along meandering river system in oxbow development stage.
3. Classification - Class A - distinctive.
4. Sensitivity(1) - Affects all three levels.

(1) Based on distance from major highway(s).

Diversion M-42 to M-24

1. Character type - Intensively cultivated, low relief area.
2. Character subtype - None.
3. Classification - Class C - minimal.
4. Sensitivity(1) - Level 3 - lowest sensitivity.

Wetland Restoration

1. Character type - Intensely cultivated, rolling pothole region.
2. Character subtype - None.
3. Classification - Class C - minimal.
4. Sensitivity(1) - Level 3 - lowest sensitivity.

Tributary Dams

T-94 - Iron Springs Dam

1. Character type - Sparsely vegetated, eroded, and rough relief.
2. Character subtype - Mostly grassland.
3. Classification - Class B - common.
4. Sensitivity(1) - Level 3 - lowest sensitivity.

T-150 - Dead Colt Creek

T-158 - Timber Coulee

T-240 - Unnamed

The following visual quality objectives can be considered the same for all three tributary dams.

1. Character type - Sparsely vegetated, intensively cultivated, eroded, pothole region.
2. Character subtype - Coulee development.
3. Classification - Level B - common.

T-240 has a Level 2 sensitivity(1) while T-150 and T-158 have a Level 3 sensitivity. A Level 2 sensitivity only increases a positive or negative effect to the middle ground sensitivity (as described in the method section) and is not considered a significant impact for individual evaluation.

(1) Based on distance from major highway(s).

UNIQUE CHARACTERISTICS

On the basis of human use and the population of plants and animals within its boundaries, the Sheyenne River basin is one of the major wildlife, scientific, and recreational areas in North Dakota. The basin contains such unique areas as the wooded draws in Barnes County, wetlands for waterfowl production, the Little Yellowstone area near Kathryn, the Fort Ransom and Anselm area woods, and the Mirror Pools area, sandhills, and grasslands in the lower basin. Together, these diverse components form a major North Dakota habitat and one of the few forests in the grassland and agriculture biome.

A preliminary list of natural areas in North Dakota has been published by the North Dakota Natural Science Society (Kantrud, 1973). These areas are relatively undisturbed tracts containing representative biotic communities. About 30 acres have been identified in the Sheyenne basin that contain unique flora or fauna or unusual geologic, paleontologic, or archaeologic features.

The Sheyenne sandhills (delta) is a relatively uncommon area in North Dakota. As mentioned earlier, this area supports uncommon vegetation which in turn sustains a unique population of animal life. This tall-grass prairie ecosystem developed on the sand delta of the Sheyenne River where it emptied into glacial Lake Agassiz. There are about 70,000 acres of sandhills in North Dakota. The only other sandhills-type ecosystem in the State consists of about 80,000 acres and is located near Towner in the Souris River basin.

The expanse of deciduous forest associated with the Sheyenne sandhills is probably the most important wildlife habitat in the basin, providing some of the most diverse and unique wildlife habitat in this agricultural-prairie biome. This island of deciduous woods provides refuge for the many species of flora and fauna of eastern affinities in the western periphery of their range. Populations of many North Dakota plant and animal species are concentrated almost entirely in this area.

The riparian (gallery) forest along the Sheyenne River is very important wildlife habitat, providing food and cover for a great variety of terrestrial vertebrates. Some of these species are found only in

association with this community while others have their greatest abundance here. Many riparian forests have been lost through agricultural land clearing and construction of reservoirs. Thus, the forest along the Sheyenne River provides valuable wildlife habitat and associated values and represents an ever-increasing percentage of this type of habitat in the State.

The riparian forest and its fluvial system are dynamic and interdependent. The natural balance in the floodplain is easily upset by human interference. To understand the riparian forest/fluvial system balance, two points must be recognized: (1) flooding is a natural process rather than a natural hazard, and (2) if we are to maintain the integrity of the riverine system, we must consider the channel and floodplain as complementary (Keller, 1977).

The most important scientific basis for protection of these habitats is their unique diversity of wildlife. California studies indicate that more kinds of birds breed in riverine forests than in any other habitat type (Brumley, 1976; Gaines, 1977). Many species, including threatened, endangered, and rare species, depend on these forests for their survival.

The importance of riparian vegetation to fish has been well documented (Hynes, 1970; Mann, 1975). Fish use submerged tree roots along the banks of streams and rivers for cover. Terrestrial insects dropping from overhanging vegetation are an important source of food. Other materials such as leaves and twigs which enter the water serve as substrates for bacterial and fungal action. The resulting detritus is a vitamin-rich food supply for certain aquatic insects which are indispensable to the diets of many fish species. In addition, trees provide shade for temperature regulation, a critical factor for aquatic life.

Well known recreational values of riparian areas include fishing, bird watching, nature photography, hunting, and canoeing. Other social benefits are derived in the form of open space, outdoor education, natural beauty, and scientific study. Even a narrow band of riparian vegetation, such as exists in the glacial lake plain area downstream of Kindred, provides some of these values.

ANTICIPATED FUTURE CONDITIONS

This section describes some of the conditions expected to occur in the future. These conditions concern fish and wildlife resources only.

Woodland clearing rates in the State range from less than 1 percent to about 5 percent. The loss of woodlands in a State that is less than 1-percent forest is significant. The clearing of natural woodland in the valley bottom of the Sheyenne River basin is estimated to occur at the rate of about 0.75 percent per year. If the clearing of shelterbelts and planted woodlands is included, the rate increases to about 1.5 percent per year. This rate will probably decrease slightly in the future.

In the last 100 years, over 40 percent of the wetlands in the 48 continental States have been drained (Water Information News Service, 1977). From 1964 to 1968, drainage eliminated about 67,000 wetland acres in North Dakota, or about 5 percent of the total wetland inventory in 1964. It is estimated that about 2 percent of the wetlands in the Sheyenne River basin are drained per year. The average size of the wetlands drained is about 1.2 acres. The drainage rates and amounts vary between areas and years because of climatic conditions, types of wetlands present, land use, and other factors.

Some of the wetlands that are most likely to be drained are those on agricultural lands that store water for short periods of time. Even though these wetlands are temporary water storage areas, they are extremely important to waterfowl in the spring of the year.

Both the wetland-drainage and woodland-clearing rates will probably decline slightly in the near future, especially in the valley areas where most land suitable for agricultural purposes is already put to that use. However, areas of marginal agricultural value will continue to be cleared and drained.

Residential development is expanding into the wooded areas of the valley, primarily south of Valley City, south of West Fargo, and in the Kindred area. This development will probably continue and result in a decline in the amount and value of riparian woodlands in these areas.

Logging is not a big business in the Sheyenne River basin; only two loggers operate in the lower basin. Both are small, dealing in specialty products, and have another source of income. Loggers in the lower basin remove about 200,000 board-feet of wood products annually. About one-half of this total comes from the clearing of shelterbelts. Not much increase is foreseen in this area.

The Soil Conservation Service and the North Dakota Forest Service plant about 500 acres of vegetation per year in the basin. These plantings are mostly for shelterbelts and windbreaks located in upland areas, not in the valley bottom. Although these plantings provide valuable wildlife habitat, they are not as valuable as woodlands in the valley bottom. In terms of acreage, the amount of land being planted is approximately equal to the amount of land being cleared. This balance is expected to continue in the future.

Because of the existing political climate in North Dakota, the National Wildlife Refuge System, the U.S. Fish and Wildlife Service's Wetland Easement Program, and the State Game Management program are not acquiring lands. This policy is not anticipated to change in the near future.

FISH AND WILDLIFE OBJECTIVES

Because of the complex nature of environmental needs and goals, it is difficult to be very specific in describing objectives. The fish and wildlife objectives are rather broad and are presented in the form of needs or problem statements. These needs and objectives were obtained through public workshop meetings, various meetings and conversations with natural resources agencies, or by reviewing the value of the basin's resources.

General objectives for fish and wildlife resources involve vegetation, wildlife, and water quality. These objectives are as follows:

1. Improve the water quality of the Sheyenne River and Lake Ashtabula to enhance fish and wildlife habitat.
2. Maintain the scenic values of the Sheyenne River valley.
3. Manage, preserve, and enhance fish and wildlife habitat.
4. Manage and preserve the biological and geological resources and ecosystems of the basin.

No specific goals have been established for acquiring or developing land. In addition, there have not been extensive studies or inventories of the existing or needed resources. Therefore, the fish and wildlife objectives are in the form of general statements and are not specific as to the amount of production or number of acres needed. A discussion of the fish and wildlife objectives follows.

The preservation and/or reduction in the loss of existing habitat is very important, especially in the case of woodland because of its value and scarcity. This objective presents an obvious problem because of the anticipated clearing and draining of woodlands and wetlands. Preserving and managing more wetland and woodland habitat is a long-term goal.

The major fishery needs seem to be continuing to stock Lake Ashtabula and increasing the low flow in the Sheyenne River. The increased low flow would enhance fish survival by increasing the oxygen content of the water.

Generally, wildlife populations seem to be at desirable levels. As a result, the goal would be to maintain these levels. One notable exception is the prairie chicken, which is slowly increasing its populations in the Sheyenne National Grasslands. Therefore, maintaining this trend and preserving or enhancing prairie chicken habitat should be an objective.

The preservation of the sandhills environment has been indicated as an important goal. The sandhills are a unique area in North Dakota and provide habitat for a number of State-designated rare plant and animal species.

As discussed previously, a number of unique natural areas in North Dakota have scientific, biological, educational, geological, or other values. A preliminary inventory of scientific areas has been conducted and about 30 areas have been located in the Sheyenne River basin. About 15 of these lie between Kindred and Kathryn. Other unique areas should be inventoried and the valuable areas identified for preservation.

Because of its wildlife, recreational value, and fish hatchery potential, the Mirror Pools area has been identified as a site that should be preserved. In addition, a number of small, spring-fed streams that flow into the Sheyenne River in the delta area have better water quality than the river itself and provide habitat for some rare species of fish and places of refuge for aquatic organisms that require cleaner water. An objective would be to preserve and manage these spring-fed areas.

It would be desirable to improve the water quality of the Sheyenne River and Lake Ashtabula for fish, wildlife, aesthetic, and recreational purposes.

The Sheyenne River valley has outstanding scenic qualities. The diversity of habitat types and relative abundance of vegetation combine to create valuable aesthetic qualities. The scenic characteristics of the area should be preserved.

The alternatives proposed to accomplish these objectives would have varying effects on fish and wildlife resources. Some objectives are more directly related to preserving, enhancing, or creating fish and wildlife resources than others, but all of the alternatives would have some beneficial effects.

ALTERNATIVES FOR FISH AND WILDLIFE RESOURCES

Most of the identified problems and needs concern the preservation of the wildlife habitat and existing vegetation and the maintenance of natural areas in the Shevenne River basin. The following outline of alternatives shows possible means to accomplish these goals. Some of these goals have already been accomplished by various agencies, while others need more emphasis to achieve the desired output. Since the specifics of these alternatives have not been formulated, the intent is to suggest alternatives that best address planning objectives in the overall public interest to achieve the desired goals.

Selection of a combination of fish and wildlife alternatives will depend on the plan formulated for other purposes (flood control, water supply, etc.). Also, as the plan formulation process continues, new fish and wildlife alternatives may be developed. A summary of the more desirable or implementable plans is presented below.

A. Nonstructural

1. Studies

a. Determine the value of small springs coming into the Sheyenne River. The value of these springs for forage fish and places of refuge has not been studied. Such a study would facilitate assessment of the impact of activities in this area.

b. Determine the value of natural vegetation in the Sheyenne River basin. The basin has relatively more woodland than other areas of the State. It also contains many rare species of plants and animals. The importance of the vegetation to some forms of wildlife has been described, but relatively little research has been done on its importance to many other species.

c. Inventory unique areas in the basin. Several areas of scientific value have been identified in the basin. Other areas of wildlife, geological, vegetational, and educational value should be inventoried.

2. Programs

a. Reactivate the soil bank program. The soil bank program was started in the 1950's when farm crops were in surplus and was discontinued when supply again equaled demand. In this program, the Federal Government rented land for 10 years and seeded it. A renewed soil bank program would enhance wildlife habitat and production.

b. Implement a program for the preservation and management of existing wetlands. This program could consist of purchase, easement, or regulation. Some existing programs could be expanded and existing drainage regulations could be more strictly enforced or a wetland program similar to the soil bank program could be developed.

c. Implement a program for the construction of small retention dams. Some small retention dams and stock watering ponds now exist. Participation in these programs could be encouraged and the programs could be expanded to include construction for other purposes.

d. Encourage the planting of more shelterbelts. Shelterbelts would provide habitat, especially for nongame species, in upland areas. They would also provide aesthetic benefits and erosion control.

e. Develop greenbelt areas along rivers. The program would consist of the planting of vegetation along rivers, mostly in the valley bottoms. Extensive benefits would accrue to wildlife, recreation, erosion reduction, water quality improvement, aesthetic values, and water runoff reduction.

f. Implement a program for the preservation and management of existing woodlands. This program could consist of purchase, easement, or regulation. Many benefits could be derived just by regulating the amount and location of land clearing. This can be done through land-use plans, ordinances, etc. Because of the high value of woodlands in the basin, this program could have many benefits.

g. Encourage the designation of the Sheyenne River as a Wild and Scenic River. The designation of the Sheyenne River as a State or Federal scenic or recreational river would benefit wildlife by protecting some of the habitat.

h. Implement the State Nature Preserves program in the Sheyenne River valley. The identification and inclusion of some of the unique areas in the basin in the State Nature Preserves program would protect some of the more valuable areas. These areas have scientific, educational, wildlife, or other values.

i. Encourage participation in the water bank program. The water bank program began in 1972. It is similar to the soil bank program in that the Soil Conservation Service rents land for 10-year periods and seeds the area for wildlife habitat. Encouraging more participation and making more funds available for the program would benefit wildlife habitat and production.

j. Implement a program to improve the water quality of the Sheyenne River and Lake Ashtabula. Improving water quality by land and sewage treatment measures would benefit fish and wildlife. This would in turn improve the fish, wildlife, recreational, and aesthetic values of the basin.

3. Plans

a. Develop wildlife management plans for the basin:

- Deer.
- Small game.
- Prairie chicken.
- Waterfowl.
- Nongame species.

Plans for the management of wildlife can be developed or expanded. This would provide information on production, important habitat, etc. This alternative could include plantings, land acquisition, regulations, and easements.

b. Develop plans to preserve unique areas in the basin:

- Sandhills (Sheyenne delta) area.
- Woodlands.
- Prairie grasslands.
- Wetlands.
- Mirror Pools area.
- Natural areas.
- Spring-fed streams.
- Scenic qualities.

Some existing programs for the preservation of unique areas should be better utilized or expanded. A number of areas in the basin could be protected. To augment the Nature Preserves Act of 1975, parks and game management areas, regulations, and easements could be used in this alternative.

c. Develop a forestry management plan for the basin:

- Multiple use.
- Single use.

Participation in private forestry management programs is expected to increase in the future. Therefore, forestry management plans would probably be oriented toward wildlife, recreation, fuel wood production, watershed management, and scenic qualities.

d. Develop a fishery management plan for the basin:

- Reservoir.
- River.
- Water quality.
- Low flows.

Improving water quality and increasing low flows would increase fish survival. Fish stocking and reservoir drawdown would also be included in fishery management plans.

e. Develop a land use plan for the basin. Some land use plans are now being developed. These include recreation plans, floodplain regulations, and zoning ordinances. Land use plans provide for preservation and proper management of resources.

B. Structural

1. Encourage use of more land treatment measures. This alternative would promote more terraces, diversions, stock ponds, shelterbelts, reforestation, etc. Benefits would accrue to wildlife, recreation, erosion, aesthetics, and other resources.

2. Improve low-flow characteristics of streams. Increasing the low flows of the river would increase the oxygen supply, thereby increasing fish survival. Low flows could be increased through Garrison Diversion return flows or by modifying the operation of Baldhill Dam.

3. Restore drained wetlands and increase the size of existing wetlands. Many drained wetlands can be restored and existing wetlands can be increased in size to enhance wildlife habitat. Waterfowl and recreationists would be the main beneficiaries of this alternative, but there would also be benefits to other forms of wildlife, aesthetics, erosion control, water quality, and water storage.

4. Provide in-stream structures for fishery enhancement. Fisheries in streams and rivers can be enhanced by simple, small rock or log dams which create pools and holes for fish. Rocks and gabions could be placed in the river to provide resting areas for fish and to control erosion. Vegetation planting and protection of vegetation along streams are desirable to maintain and improve fish habitat, temperature regimes, and food sources.

Although most of these alternatives are not implementable by the Corps, they have much merit and should be considered for implementation by other agencies, groups, or citizens committees. Some of these alternatives already exist, but have funding, manpower, or other constraints. Recommending them here may help overcome some of these constraints.

All of the alternatives presented above would benefit the natural resources of the basin and their users. The interest/capability/participation in implementing these alternatives are presented in table D-10. Also presented in this table are recommendations as to which alternatives are the most practical to implement. These recommendations are based on determinations by the Corps and State and Federal natural resource agencies as to which alternatives are the most desirable to implement for fish and wildlife purposes.

TABLE D-10
AGENCY INTEREST, CAPABILITY, PARTICIPATION, AND RECOMMENDATIONS
FOR ENVIRONMENTAL ALTERNATIVES (PRELIMINARY)

Alternative	Agency 1/												Recommendation 2/
	C of E	N.D. G&F	U.S.FWS	U.S.FS	N.D.FS	N.D.SWC	SCS	ASCS	N.D.SPD	Univ.	WP	N.D.SPA	Practical for implementation with or without Corps participation
Studies													
Determine value of springfed streams	x	x o *	x	x						x o			R
Determine value of natural vegetation	x	x o *	x o	x o *	x o *	x	x		x	x o *	x		R
Inventory of unique areas in Sheyenne basin	x	x o	x	x	x o				x o *	x o *	x	x	R
Programs													
Reactivate soil bank program	x	x	x	x	x	x	x o *	x o			x	x	
Program to preserve and manage wetlands	x	x o *	x o *	x o	x o	x o *	x o			x	x		R
Construction of small retention dam	x o	x o	x o	x o		x	x o *	x o			x o		
Plant more shelter-belts	x o	x o	x o	x o *	x o *		x o *	x o *		x	x o		R
Greenbelt along river	x	x o	x o	x o	x o	x	x o		x o *	x			R
Preserve and manage woodlands	x	x o *	x o *	x o *	x o *	x	x		x o *	x	x		R
Designate S. River a scenic river	x	x	x	x	x	x	x		x o *	x	x	x o	R
Implement State nature preserves program	x	x	x	x	x		x		x o *	x	x	x	R

Alternative	C of E	N.D. G&F	U.S.FWS	U.S.FS	N.D.FS	N.D.SWC	SCS	ASCS	N.D.SPD	Univ.	WP	N.D.SPA	Recommendation 2/ Practical for implementation with or without Corps participation
	Agency 1/												
Participate in water bank program	x		x			x	x o *	x o *					R
Improve water quality	x o *	x	x	x	x	x o	x o *	x o *	x	x	x o	x	R
Plans													
Develop wildlife mgt. plans	x	x o *	x o *	x o *	x o *				x	x o			R
Develop plan to preserve unique areas	x	x o *	x o *	x o *	x o *				x o *	x o	x		R
Develop forestry mgt. plan	x	x o *	x o	x o *	x o *		x		x o	x o			
Develop fishery mgt. plan	x	x o *	x o *						x o	x o			R
Develop land use plan	x o	x	x	x o	x	x	x		x o	x	x	x o *	R
Structural													
Use more land treatment measures	x	x o	x	x o	x o	x	x o *	x o *		x o		x	R
Improve low flow characteristics	x o *	x o	x o			x				x	x o *		R
Restore drained wetlands or increase existing wetlands	x o *	x	x o *			x	x o *	x o			x o *		R
Provide in-stream structures for fishery enhancement	x o *	x o *	x o			x				x	x		R

1/ x Indicates interest in alternative.
o Indicates capability of implementing, planning, or constructing alternative.
* Indicates participation in implementing (permits, supervise construction, review plans, etc.)
C of E = Corps of Engineers
N.D.G&F = North Dakota Game and Fish Department
U.S.FWS = U.S. Fish and Wildlife Service
U.S.FS = U.S. Forest Service
N.D.FS = North Dakota Forest Service
N.D.SWC = North Dakota State Water Commission
SCS = Soil Conservation Service
ASCS = Agricultural Stabilization and Conservation Service
N.D.SPD = North Dakota State Parks Department
Univ. = Universities
WP = Water and Power Resources Service
N.D.SPA = North Dakota State Planning Agency

2/ Alternatives were recommended (R) based on their value to fish, wildlife, vegetation, etc., implementability, and suitability to be utilized with or without Corps participation in the area.

DISCUSSION OF THE
VALUE OF RIPARIAN AND WETLAND HABITAT
TO FISH AND WILDLIFE
by Robert Anfang

THE PROBLEM

In the 1930's, North Dakota had an estimated 600,000 acres of forested land, much of it associated with rivers (riparian areas), while the upland areas were generally dominated by prairies and cropland. Today, an estimated 400,000 acres of forest land remains, much of it riparian and most of it on the sideslopes of the steeper valleys. This 200,000-acre loss amounts to a 33 percent decline in forest land in less than 50 years. Most of the woodland losses occurred during the construction of the Missouri River mainstem reservoirs and as a result of land clearing associated with agricultural development.

HISTORIC CONDITIONS

Early historical records give detailed accounts of the vegetation along the navigable rivers in North Dakota. For example, upon entering North Dakota, Lewis and Clark (Cowes, 1893, cited by Burgess et al., 1973) observed that:

"On both banks of the Missouri are low grounds which have much more timber than lower down the river (near the Cannonball River).

The country through which we passed has wider bottoms and more timber than those we have been accustomed to see . . ."

EARLY CHANGES IN RIPARIAN CONDITIONS

The native American Indian tribes of the area, who were mostly sedentary horticulturists (Lehmer, 1970), contributed to changes in the riparian conditions. They cleared some floodplains for cropland and cut timber for firewood and home construction.

The Homestead Act of 1868 provided the incentive to settle the west and resulted in the extensive clearing of floodplain forests for agricultural use. Since then, most of man's impact on the remaining forests has been in the forms of reservoir construction, grazing, selective cutting, and residential expansion.

"The settlers cleared large expanses of native vegetation, using some for building materials; but for the most part, they did not view the woodlands as a valuable resource, and removed them so that the soil of the alluvial bottom could be put into production for agricultural and domestic livestock grazing purposes." (Carothers, 1977) In response to needs created by changing water regimes and damaging floods, dams were constructed, inundating and destroying even more riparian woodland.

Another threat to riparian habitat is domestic livestock grazing. Many riparian areas are approaching maturity at a time when grazing has prevented the establishment of seedlings. When many of these mature stands die, there may be no young trees to take their place.

THE HELENDALE TOWNSHIP STUDY: AN EXAMPLE OF RIPARIAN CHANGE

Compared with other river basins in the State, the Sheyenne basin has a large proportion of woodland: 1 percent. More than 70 percent of the basin is used for agriculture. A good indication of the change in land use is shown in the study by Burgess (1964) which examined the changes of Helendale Township in southeastern North Dakota by comparing the presettlement vegetation as recorded in the 1871 General Land Office survey records with the land cover as it existed in 1961. The results of this study are shown in table D-11.

Table D-11 Vegetational composition of Helendale Township, North Dakota, 1871 and 1961

Vegetation Type	1871 acres	1871 percent	1961 acres	1961 percent
Cultivated fields, pastures, and farmsteads	0	0	20,617.01	89.50
Tall grass prairie	18,662.40	81.00	0	0
Savanna	2,103.55	9.13	-	-
Forest	1,937.66	8.41	806.40	3.50
Marsh	251.14	1.09	0	0
Shrubland	85.25	.37	-	-
Shelterbelts	0	0	503.95	2.18
Roads	0	0	112.70	.48
Savanna and shrubland	-	-	638.21	2.77
Grazed sand prairie	-	-	361.73	1.57
Total	23,040.00	100.00	23,040.00	100.00

From: Burgess, 1964.

It is evident that great changes have taken place in the vegetative cover of Helendale Township. The grassland has been almost totally destroyed, while the amount of savanna and forest has been reduced. Most of these changes can be attributed to the farmer because of his agricultural practices; his needs for fuel, building materials, and shelterbelts; and his questionable road building practices (Burgess, 1964).

THE VALUE OF RIPARIAN HABITAT

For many years, riparian habitats were viewed only for their consumptive value, while the nonconsumptive uses such as aesthetics, recreation, and wildlife were frequently ignored. Recent research has shown that substantial numbers of

both game and nongame wildlife species are dependent on riparian vegetation. The following is a review of some of the literature describing the value of riparian habitats to wildlife.

The results of a study in Arizona (Carothers et al., 1974) substantiated two points that had long been suspected by many wildlife biologists: (1) that vegetation manipulation in native riparian communities was extremely detrimental to breeding bird populations, the extent of the impact being significantly correlated with the degree to which phreatophytes were removed, and (2) that, for a given number of acres of habitat, the riparian type supports higher population densities than any other forest habitat type.

Another study in the southwest (Stevens et al., 1977) showed that riparian habitats support up to 10 percent higher migrant passerine densities and higher species diversity than do adjacent nonriparian habitats, indicating that the importance of riparian habitats to migrant passerines is substantial. This study also indicated that when riparian habitat is removed or severely manipulated, not only are the riparian species of the area adversely influenced, but wildlife productivity in the adjacent habitat is also depressed.

Riparian habitats are also valuable to other wildlife species. This was shown in a study in Oklahoma (Barclay, 1978) where bird, mammal, amphibian, reptile, and vegetation data indicate that unchannelized sites were significantly more valuable as wildlife habitats than were channelized sites. There were about 1.3 and 1.8 times more bird and plant species in unchannelized than in channelized sections of rivers. Most "old channelization" sites show no evidence of recovery comparable to the control sites.

Boldt et al. (1978) studied the effects of cattle grazing on wooded draws in southwestern North Dakota on the Little Missouri National Grasslands. These wooded draws are believed to provide valuable, perhaps critical, habitat diversity for both wildlife and livestock. The deciduous tree/shrub woody draws appear widely threatened by multiple impacts, of which one of the most visible and detrimental is cattle grazing. Boldt et al. found that protection from cattle grazing improves survival of most underplanted trees and shrubs, development of tree sprout clumps, and height growth of chokecherry and American elm seedlings.

Conine et al. (1978) found that many species of birds did not use agricultural lands, while insectivorous species suffered severe losses through agricultural conversions. However, fringillids (sparrows, finches, buntings, and grosbeaks), doves, some flycatchers, and the brown-headed cowbird used agricultural areas to a high degree. Riparian habitat associated with other habitat types was highly valuable. These studies along the lower Colorado River showed that, with respect to densities of riparian birds, agricultural situations did not support populations as large as those in native riparian communities. In the study, 19 of the 41 riparian species known to occur in the area were observed in agricultural areas; 21 other riparian species do not occur in agricultural areas. These findings suggest that destruction of riparian vegetation has an overall negative impact on riparian avian species.

HABITAT CONVERSION

Habitat conversions may have the most severe impact on rare avian species. A number of rare species of birds are found in the lower Sheyenne basin, as discussed earlier in this report. Noon et al. (1979) reviewed the literature

on the effects of habitat changes on northern hardwood forest bird communities and found that logging has little effect on the diversity or density of most bird species. They discovered that extensive habitat disturbance may have its most pronounced effects on the rare species of the community. The rarity of these species is indicative of their extreme specialization to some aspect of their environment. Noon et al. suggest that, until the requirements of these sensitive species are known, large tracts of undisturbed forest land be preserved; this appears to be the only way of ensuring the persistence of these rare species. In addition, 21 species of birds that utilize woodlands of the lower Sheyenne basin are on Federal or State endangered or threatened species lists or on the Audubon Society's Blue List of endangered birds (table D-12). The study by Noon et al. gives support to the objective of preserving the woodlands of the lower Sheyenne basin. The direct relationship between the loss of lowland hardwood acreage and declining rare bird populations has also been observed by Samson (1979).

HABITAT FRAGMENTATION

The fragmentation or breaking up of the habitat has a pronounced effect on the species composition of the area, and may be just as detrimental as habitat destruction. Robbins (1979) found that many migratory songbird species are dependent on large, unbroken tracts of forest during the breeding season. These species are disppearing from localities where forests are becoming fragmented. One forested area near Laurel, Maryland, was fragmented by a reservoir and freeway; as a result about half of the long-distance migrants in the area disappeared, including the broad winged hawk, yellow-throated vireo, worm-eating warbler, ovenbird, and others.

Another example occurred on an island in the Potomac River near Washington, D.C. The forest was fragmented by highways; the result was the disappearance of the yellow-throated vireo, scarlet tanager, yellow-billed cuckoo, and other birds. Many of the species listed above also occur in the Sheyenne basin.

Table D-12 List of threatened, endangered, or uncommon bird species associated with woodlands in the Sheyenne River basin (From: Tri-College University, 1977; U.S. Forest Service, 1970)

Yellow warbler	Yellow-billed cuckoo
Cerulean warbler	Barn owl
Sharp shinned hawk	Barred owl
Cooper's hawk	Pileated woodpecker
Swainson's hawk	Redheaded woodpecker
Ferruginous hawk	Hairy woodpecker
Common nighthawk	Scarlet tanager
Green heron	Yellowbellied sapsucker
Bald eagle	Yellow throated vireo
Purple martin	American woodcock
Kestrel	

FLOOD REGIME ALTERATION

An effect associated with reservoir construction (other than the obvious one of destruction and fragmentation of the forest area itself) is the altering

of the flooding regime. Instead of periodic inundations of short duration, the floods may be fewer but more catastrophic (the effects of inundation are discussed elsewhere in this report).

Robbins (1979) points out that one of the worst disasters that can befall a bird community is the creation of a reservoir. In large sections of the north central United States, the most extensive wooded areas are those in stream valleys (the Sheyenne River valley is a perfect example). When such valleys are impounded, the more moist and generally most productive forests are destroyed, and many of the adjacent upland forest areas are fragmented to the point that they can no longer support the sensitive species of migratory birds.

The following are included in Robbins' management recommendations:

a. Avoid fragmentation of forests.

b. Manage large blocks of forests.

c. Preserve selected areas of mature forest.

d. Retain vegetational diversity.

e. Minimum forest areas to be preserved should be approximately 2,500 acres.

f. Wooded fragments should be connected by a corridor (i.e., along a stream) or by planting vegetation.

WOODED AND HERBACEOUS HABITAT ALTERATION

Stauffer and Best (1980), in a study of riparian communities in Iowa, found that the mean density of breeding birds increased from herbaceous habitats to upland woodlands to floodplain woodlands. Wooded areas supported a maximum of 32 species; herbaceous habitats supported 8 species. Although upland and floodplain woodland habitats were similar in species richness, the latter were more important in terms of the bird densities supported. In addition, bird-species richness was found to increase with the width of wooded riparian habitats; a similar trend was evident for herbaceous areas.

Habitat alterations can have significant effects on bird populations. Stauffer and Best concluded that if all woody vegetation were removed from a riparian community and herbaceous cover remained, 32 of the species studied would be eliminated and 5 might decrease in numbers; the remaining 4 could benefit. Reduction of woody vegetation to narrow strips could provide more favorable breeding habitat for 12 species, but densities of 16 species might decrease, and 6 species would be eliminated.

Geier and Best (1980) studied small mammal populations in Iowa riparian areas. They found that small mammal species diversity was highest in channelized and heavily grazed upland habitat. (Other studies have shown lower species diversity within 2 years of channelization.) The small mammal diversity indexes for the various habitat types were channelized, 2.18; heavily grazed upland, 2.06; wet floodplain, 1.54; lightly grazed upland, 1.23; ungrazed upland, 1.05; and dry floodplain, 1.02.

In a study in Missouri, Zwank et al. (1980) found that white-tailed deer use bottomland woodlands throughout the year, with heavy use in winter as yarding areas. Woodlands in agricultural areas are especially important to deer as corridors, migration routes, food, and cover. Zwank et al. concluded that the destruction of naturally vegetated bottomlands constitutes a threat to viable white-tailed deer populations in agricultural areas of the Midwest.

SUMMARY

The Sheyenne basin is one of the most heavily wooded river basins in the State, while the lower basin is one of the few remaining relatively large areas of bottomland hardwoods. The value of the woodlands for birds, white-tailed deer, rare bird species, and other wildlife has been demonstrated, and the adverse impacts of habitat alterations have been described. The woodlands of the lower Sheyenne basin also support a number of rare plant species which are present because of geologic conditions, microclimatic characteristics, and habitat created by the existing woodlands. A small-sized Kindred reservoir, with a flood pool at 1,000 feet would affect 4,201 acres of woodland, or 12 percent of the existing woodland in Ransom and Richland Counties. This would have a very significant effect on the wildlife populations in the basin and could result in the elimination of some of them.

The vegetation in riparian habitats stabilizes soils and supplies organic matter which sustains aquatic communities. Nutrient-rich silt, deposited periodically in these habitats by floodwaters, enriches soils that support bottomland hardwood forests, forage for wildlife, and outdoor recreation (John, 1979). Wildlife use of riparian areas, with their available water and maximum edge, is considerably higher per unit area than in most other vegetative types.

Floodplains in their natural and undisturbed state provide (John, 1979):

a. Water resource values: storage and slow release of floodwaters, water quality maintenance, and groundwater recharge.

b. Living resource values: fish, wildlife, and plants.

c. Cultural resource values: open space, recreation, archeological and historical sites, scientific study, outdoor education, and natural beauty.

d. Cultivated resource values: agriculture, aquaculture, and forestry.

Various activities and programs at the National, State, and local levels can be undertaken to preserve the floodplain and riparian values. Some of these methods have been discussed in the alternatives section for fish and wildlife purposes. The U.S. Fish and Wildlife Service and Soil Conservation Service have programs available for preservation, management, and enhancement of the resources. One of the most desirable and worthwhile measures that could be implemented in the Sheyenne basin is a land use plan that would guide future activities for the preservation of natural resources.

WETLANDS AS WILDLIFE HABITAT

Historical

In 1929, Congress enacted the Migratory Bird Conservation Act which authorized the Federal Government to acquire land and water areas for waterfowl refuges. Soon after this legislation was passed, it became clear that the Nation's waterfowl were becoming seriously threatened. The disappearance of vital habitat was steadily reducing the population of ducks during the early 1930's. Millions of acres of wetlands were being drained for agriculture. This drainage, in combination with the drought, was destroying important waterfowl habitat. Wetlands are crucial to waterfowl for reproducing, resting during long migration flights, and surviving winters. Without such habitat, the birds suffer and their numbers decline (Migratory Bird Conservation Commission, 1979).

In the last 100 years, over 40 percent of the wetlands in the United States have been drained (Water Information News Service, 1977). During the years 1940 to 1964, more than 45 million acres of U.S. wetlands were drained. The annual average area drained for the years 1959 through 1964 was 1,403,385 acres (Congressional Record, Feb. 24, 1967).

For years, marshes and ponds have disappeared as agriculture has expanded. In the prairie pothole region of Minnesota and the Dakotas, agricultural drainage destroyed an average of more than 136,000 acres a year from 1959 through 1964 (Congressional Record, Feb. 24, 1967). From 1964 to 1968, the rate of drainage fell, but still approximately 67,000 acres were drained: about 5 percent of the total prairie pothole region wetland inventory in 1964. Table D-13 shows the area and percent of wetlands drained in the five counties of the lower Sheyenne basin. On the average, over 60 percent of the wetlands in these counties have been drained.

Table D-13 Wetland drainage in five counties containing the lower Sheyenne River basin

	Barnes	Cass	Griggs	Ransom	Richland	Ransom (1)	Richland (1)
Existing wetlands (2) square miles	90	15	65	45	50	25	2
Wetlands drained (3) square miles	173	950	11	90	530	24	35
Wetlands drained as a percent of total wetlands	65%	95%	15%	65%	90%	50%	95%

Compiled by John Kittelson, St. Paul District.

(1) Wetland figures for Sheyenne River basin only.

(2) Estimated from N.D. State Water Commission maps showing legal drains in North Dakota counties.

(3) Estimated from "Land Use and Assessment and Needs (Lakes - Drainage Basins - Counties - Areas - State)", by Non-Point Source Task Force, N.D. State Soil Conservation Committee; and from "Wetland Survey Summary Sheet for Sheyenne Basin", by U.S. Fish and Wildlife Service, Bismarck, N.D.

Wetland Values

Prairie potholes are the backbone of duck production in North America. It is estimated that the prairie pothole region, forming 10 percent of the total waterfowl breeding area of the continent, produces up to 50 percent of the continent's duck crop in an average year. North Dakota plays a key role in this duck production, typically hosting about 40 percent of the breeding ducks in the contiguous 48 states (U.S. Fish and Wildlife Service, 1980).

Based on historical data, an estimated minimum of 5 million wetland acres were once located in the prairie pothole region of North Dakota, including the Agassiz Lake Plain. In 1967, the Northern Prairie Wildlife Research Center conducted a wetland inventory in the State that indicated approximately 2.2 million acres of wetlands remained in the prairie pothole region. This figure represents a 56 percent decrease. In the Sheyenne basin, an estimated 2 percent of the wetlands are drained per year. The average size of the wetlands drained is about 1.2 acres. The drainage rates and amounts vary between areas and years because of climatic conditions, types of wetlands present, land use, and other factors (U.S. Fish and Wildlife Service, 1980).

Wetland restoration and temporary storage could be used to recreate some of the habitat that has been lost and to establish a diversified waterfowl habitat which also provides habitat for big game, upland game, furbearers, and many nongame species.

Waterfowl production is highly complex, requiring water and land and associated vegetation as primary elements. However, an essential prerequisite for breeding populations is a wetland base that includes different types of prairie wetlands

(U.S. Fish and Wildlife Service, 1974). A study in South Dakota (U.S. Fish and Wildlife Service, 1961) showed a strong correlation between waterfowl use and the number of depressions holding water. The relationship between acres of wetlands and numbers of waterfowl was less significant. Waterfowl prefer the privacy of small wetland areas for their courtship activities. For courtship, breeding, and feeding purposes, waterfowl were found to use wetlands as small as a tenth of an acre, which held water for a few days or weeks in April or May. A diversity of both large and small, temporary and permanent wetland areas is preferred for waterfowl production.

Considerable data are available to support the need for preservation of small ponds as part of wetland complexes and for restoration or creation of a variety of wetland types. Evans and Black (1956) indicated that small wetlands in South Dakota attracted more breeding pairs per unit than did large wetlands: "It appears that this desire for isolation in the pothole country leads to a dispersal of the population and brings about intensive use of parts of the habitat which are not otherwise used."

The importance of shallow well-vegetated wetlands for providing nesting and food values cannot be overemphasized. Smith (1971) noted that the most attractive areas are wetlands with about 80 percent emergent vegetation.

Typically, emergent vegetation in the prairie pothole region occurs in concentric peripheral bands (Stewart and Kantrud, 1972) corresponding to the shallower edges of wetland basin topography, with open surface water zones occupying the deepest portions of the marsh.

Flooding existing wetland basins to increase water surface is of questionable merit. Sacrificing emergent vegetation in existing shallow water zones by increasing water depths amounts to a trade-off by relocation. Johnson (1956), while studying the effects of water fluctuations and vegetative changes on bird populations, found that flooding larger potholes greatly reduced total waterfowl production.

The wetland complexes in the prairie pothole region support diverse wildlife communities. Nielson (1972) stated, "The value of such wetlands and adjacent uplands is that they contain the needed habitat for not only waterfowl and aquatic furbearers, but also for many other game and nongame wildlife species." Stewart and Kantrud (1974) found 29 breeding populations of marsh birds other than waterfowl in the Missouri Coteau region of North Dakota. That these areas are of importance to a variety of species makes their restoration and preservation a high priority.

Wildlife use varies according to a wide range of basic requirements provided by wetland habitat. Observations in North Dakota showed wetlands are heavily used during various seasons by resident species such as white-tailed deer, prairie chickens, and pheasants (U.S. Fish and Wildlife Service, June 1974). Many other species of game and nongame animals also use the area.

Sanderson and Bellrose (1969) found that pelicans, cormorants, long-legged wading birds, eagles, ospreys, cranes, rails, gulls, and terns make extensive use of wetlands. A study in South Dakota (DeBates, 1964) found the highest pheasant densities in areas containing temporary wetlands.

Wild mammals also utilize wetlands. In addition to aquatic furbearers such as muskrats and mink, fox and raccoon are attracted to marshes by food and cover (Mathiak, 1966). Big game species, particularly white-tailed deer, frequently use vegetated wetlands throughout the year.

Preservation of the existing wetland habitat is a major goal. The wildlife values of wetland complexes are very high and are associated with waterfowl and with other game and nongame species. Control of drainage practices and land use regulations would be very beneficial for preserving wetland habitat. Reestablishing portions of the original wetland base which have been altered and creating areas of temporary storage would provide many benefits to waterfowl and other wildlife species. The restoration of wetlands and wetland complexes is applicable in the intensive agricultural area of the Sheyenne basin.

TIMBER RESOURCES OF THE SHEYENNE RIVER BASIN
by Robert Anfang
Forester, St. Paul District

MANAGEMENT OBJECTIVES

The major timber resources of the Sheyenne River valley consist of the alluvial forest along the river, the upland forest located mostly on the valley slopes, the oak savanna in the sandhills, and shelterbelts and woodlots around homesteads. Basswood, American elm, green ash, boxelder, bur oak, cottonwood, ironwood, and hackberry are the major timber species in the area.

Hardwood forest can be managed for a number of purposes, including timber, water, forage, recreation, and wildlife. Management of any particular area could also include a combination of these objectives. The U.S. Forest Service (1979) has described possible management objectives for the Sheyenne National Grasslands. The timber site conditions in the area are only moderately productive, although economic returns from them are possible. Water quality improvement, particularly temperature and sedimentation, could be obtained through forest land management. Wildlife and aesthetics could be enhanced by maintaining and increasing the diversity of vegetative species in the area. Forest lands in the area have moderate grazing value.

Because of the low or moderate value of forest lands for timber and grazing, the most appropriate management direction would be toward the enhancement of water quality, recreation, aesthetics, and wildlife (U.S. Forest Service, 1979). However, small amounts of logging are anticipated to continue and the use of the woodlands for residential development is anticipated to expand.

As discussed earlier in this report, only two commercial loggers, both only part-time, operate in the lower basin. They remove about 200,000 board-feet of wood products annually. Based upon an average of 10,000 board-feet

per acre, this amounts to clearing about 20 acres per year. Approximately one-half of the wood removed comes from the clearing of shelterbelts. Not much change or increase in clearing is anticipated in the near future.

Residential development is expanding into the woodlands of the lower basin. Clearing of woodlands for home building occurs south of Valley City and West Fargo and west of Kindred. Although the rate of clearing is not known, it is expected to continue.

FOREST STAND CHARACTERISTICS

To help evaluate the impacts of anticipated changes in land use, it is useful to determine the density and volume of timber in the area. These figures can be used to compare the effects of various land management practices on the timber resource. Indirectly, this method could then be used to measure the effects on the aesthetic values in the basin.

Some research has been conducted to determine the density of tree species and the volume of timber in the lower Sheyenne basin. In conjunction with their land management plan for the Sheyenne National Grasslands, the U.S. Forest Service (1979) cruised five woodland sites in the vicinity of Kindred Reservoir. Table D-14 summarizes the Forest Service data.

Table D-14 Summary data for tree species based on five U.S. Forest Service stands (U.S. Forest Service, 1979)

Species	Trees/acre	DBH (inches)	Basal area/acre (sq. ft.)	Vol./acre (cu. ft.)	
Box elder	57.4	11.2	44.7		346.4
Ash	38.6	9.5	22.7		260.0
Elm	14.1	13.8	17.3		247.3
Basswood	1.6	20.3	2.6		28.3
Oak	3.6	9.4	1.9		23.5
Cottonwood	.1	32.0	.3		3.1
				Net	Gross
	115.4	11.1	89.5	908.6	1913.5

Nelson (1964) also studied the forests of the lower Sheyenne basin and found seven dominant tree species. Table D-15 summarizes his data.

Table D-15 Summary data for tree species based on 20 stands (Nelson, 1964)

Species	Average density per acre	Basal area/acre (sq.ft.)	Height (ft.)
Basswood	59.7	53.9	51.8
American elm	44.4	58.6	52.1
Green ash	31.3	19.7	52.0
Box elder	16.7	14.4	41.6
Ironwood	15.9	3.4	23.3
Bur oak	12.3	9.5	43.8
Hackberry	6.7	2.2	32.9
	187	161.7	42.5

Summary data for 10 stands studied by Nelson that are nearest the Forest Service study area are presented in table D-16. The results of these studies differ because of the limited number of sample plots, the different locations of the study areas, and the time interval between the various studies.

Table D-16 Summary data for tree, shrub, sapling, and herbaceous stratum (U.S. Forest Service, 1979)

	Trees		Shrubs & Saplings		Herbaceous
	Density (no./acre)	Basal area/acre (sq. ft.)	Density (no./acre)	Total Cover (%)	Density/ sq. meter
Average of 10 stands nearest USFS plots	215.2	171.7	993	9.8	78.1
Average for all 20 stands	185.2	167.2	4,060	24.8	87.8

Based on the above data, the following average values appear to be representative of the river valley:

Number of trees/acre	175
Basal area/acre (sq. ft.)	145
Net volume/acre (cu. ft.)	910
Gross volume/acre (cu. ft.)	1910

Table D-17 uses this data and summarizes the impacts of various measures on the timber resource of the Sheyenne basin.

Table D-17 Impacts on timber resources

Alternative Measure	Forest Area Affected (acres)	Trees Affected (Number)	Basal Area Affected (Square Feet)	Net Volume Affected (Cubic Feet)	Gross Volume Affected (Cubic Feet)
Baldhill Dam (5 ft. raise)	145	25,375	21,025	131,950	276,950
Kindred Dam (180,000 ac.-ft.)	4,340	759,500	629,300	3,949,400	8,289,400
Levees and Diversion (around W. Fargo)	2	350	290	1,820	3,820
Diversion (Horace to W. Fargo)	4	700	580	3,640	7,640
Diversion (M-54 to Wild Rice R.)	5	875	725	4,550	9,550
Tributary Dam (Dead Colt Creek)	40	7,000	5,800	36,400	76,400

RESEARCH AREAS

The U.S. Forest Service has established an experimental shelterbelt planting of scotch pine on the Sheyenne National Grasslands. The seed for this experimental planting was obtained from the Russian Government, and additional seed from this source is not available. The test planting is less than halfway to the age where performance data can be evaluated, and the planting is deemed to be irreplaceable. Based on frequency curves for Kindred dam, the trees are in an area that would have an inundation frequency of about 2 percent. The duration and elevation of flooding could be sufficient to kill the trees.

In 1967 the North Dakota Game and Fish Department, in cooperation with the U.S. Forest Service, initiated a utilization and browse survey in the Sheyenne National Grasslands. The data from these studies are used to estimate deer populations, habitat conditions, food preferences, population trends, and similar information. In order to obtain reliable information, the same study locations must be revisited. Some of these study plots are located within the design flood pool of Kindred Dam. The duration of flooding would kill the vegetation and render the study plots unusable.

VEGETATION/GROUNDWATER LEVEL RELATIONSHIPS IN THE SHEYENNE DELTA AREA NEAR KINDRED, NORTH DAKOTA (1)

In 1979 members of the Tri-College Center for Environmental Studies conducted a study for the Corps of Engineers to predict the vegetation/groundwater relationships on selected sites in the Sheyenne delta area near Kindred, North Dakota.

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(1) Summarized from the abstract of the study conducted by the Tri-College University, Center for Environmental Studies, Fargo, North Dakota, under contract with the Corps of Engineers. The entire report is on file at the St. Paul District Office.

These sites were selected to help predict possible vegetative changes which could result if the Kindred Dam with a permanent pool were implemented. The study was done in three parts: a literature search, correlation of plant communities to groundwater levels, and mapping the relationship of plant communities to changes in groundwater levels.

The literature search was conducted by using 13 data banks. Very few articles were found that dealt specifically with the correlation of vegetation and groundwater levels. Two hundred twenty-six citations were made and annotated in the report. As anyone attempting to use the references will note readily, the existing literature only indirectly relates to the specific problem of changing vegetation as a result of rising groundwater levels.

To correlate present vegetation of the Sheyenne delta area with present groundwater levels, 12 40-acre study sites were selected that represented the various grassland types found on the Sheyenne delta. The forested areas are found either on very thick deposits of sand where the predicted changes in groundwater level are minimal or along the Sheyenne River where inundation will be the problem rather than a rise in groundwater level. An attempt was made to select study sites near existing U.S. Geological Survey test wells. On each study site, the graminoids were sampled using a rising points analysis. The forbs and shrubs were sampled by direct counts of individual plants in 25-square-foot frames and 25-square-meter frames, respectively. These data permitted characterization of the floristic composition and structure of the vegetation at each site. The Tri-College report provides values for graminoid basal cover, graminoid relative basal cover, forb and shrub density, forb and shrub relative density, frequency, relative frequency, and importance for each community on each study site.

Available soil moisture data taken as a part of other range management studies in the Sheyenne Delta 1976-1978 were presented in the report. These data can be useful in correlating present plant communities to present groundwater levels. The experience gained from these studies was indirectly useful in predicting vegetation changes. For example, if the water table is within 2 to 3 feet of the soil surface, the vegetation is typical lowland vegetation; if the water table is 3 to 4 feet below the surface, one expects midland vegetation; and if the water table is 4 feet or more below the surface, one expects upland vegetation. If the soil is saturated or has standing water on it for 3 to 4 months, marsh vegetation exists.

The grassland of the Sheyenne delta area can be divided into three main plant communities. These are found in rather definite topographic positions and can be referred to as the upland community, midland community, and lowland community. The lowland prairie community is dominated by woolly sedge (Carex lanuginosa), baltic rush (Juncus balticus), prairie cordgrass (Spartina pectinata) and northern reedgrass (Calamagrostis inexpansa). The midland prairie community is dominated by little bluestem (Andropogon scoparius), big bluestem (Andropogon gerardi), switchgrass (Panicum virgatum), and bearded wheatgrass (Agropyron subsecundum). The upland communities are dominated by blue gramagrass (Bouteloua gracilis), Kentucky bluegrass (Poa pratensis), needle-and-thread (Stipa comata), and prairie sandreed (Calmovilfa longifolia).

In the areas that would be affected by changes in groundwater levels, the upland vegetation will generally change to midland and lowland vegetation. These vegetation types are more difficult to manage from the standpoint of grazing operations. The lowland vegetation is not readily grazed by livestock unless it is burned or mowed.

EFFECTS OF INUNDATION ON VEGETATION
by Robert Anfang
Forester, St. Paul District

The following discussion describes the impacts of temporary inundation on vegetation. The discussion applies to both the Ashtabula and Kindred alternatives. The vegetation impacts depend on a number of variables, including species and ecotypic variation; condition of floodwater; soil factors; age and physiological condition of vegetation; and timing, depth, duration, and frequency of inundation. The symptoms of injury usually include decreased shoot and root growth, decreased transpiration rate, loss of leaves, increased susceptibility to attack by predators and pathogens, and death. Some research has been done on the effects of flooding on trees, but little has been done on the effects on shrub and herbaceous vegetation.

More than 100 articles and publications were reviewed and numerous conversations were held with researchers who have conducted studies in the area of flood damage to vegetation to develop the conclusions presented below. In addition, field observations from the northeastern United States, Iowa, and North Dakota were drawn upon. The following are some of the comments and observations pertinent to this work:

1. In general, dormant season flooding causes no damage to woody vegetation. However, studies have shown that dormant season flooding is detrimental to most grasses.

2. The response to flooding varies widely within and between species. Some causes of this variation are age of vegetation, soil characteristics, general health of vegetation, geographic location, and other unknown physical-chemical conditions.

3. Plates D-14 through D-16 show damages that would result from flooding during the growing season. The analysis assumes that the flooding will occur during or near the beginning of the growing season. The Sheyenne River usually floods during April, May, June, and July.

4. The graphs assume no difference in damage from flooding at different times during the growing season although, according to the literature, this is not true. Vegetation is less able to withstand flooding late in the growing season. In addition, this type of flooding may also influence future growth rates, survival, and the relative proportions of vegetation the following year.

5. The percent loss is figured for land actually inundated. However, there is evidence that rises in the water table and soil saturation can cause death of vegetation over time and result in changes in productivity.

6. Loss of productivity is not specifically included in the percent-loss figures. Lost productivity is due to decreased growth, loss of leaves death of roots, and increased susceptibility to attack by pathogens and predators.

7. A flood may not cause a significant loss in the amount of vegetation, but it may have a significant impact on valuable wildlife habitat (the understory vegetation). The amount of vegetation may decline only slightly as a result of a flood, but the wildlife production or habitat may be reduced much more. (See plate D-14 for hypothetical relationship between vegetation loss and wildlife.)

8. Some of the variables that affect vegetation are not quantifiable. Dormant season flooding can influence vegetation by affecting the onset of growth. The following are influencing variables.

a. Depressions. - Because of topographic conditions, water from dormant season inundations can be stored for longer periods. Water storage in these depressions can cause loss of productivity or even death of vegetation (especially the understory).

b. Phenology. - The impacts on phenology are related to water storage in depressions and effects of water on spring soil conditions.

As a result of prolonged flooding during the dormant season, the cold soil and the physiological effects of water on the vegetation could cause a later start in the growing season which would affect the productivity of the stand.

c. Understory. - Dormant season flooding affects the grass and herb cover, especially the evergreen herbs that carry on some growth (and photosynthesis) during the winter season. Grasses cannot withstand dormant season flooding of prolonged durations.

d. Spring soil conditions. - The effects on spring soil conditions depend on the proximity of the dormant season flooding to the growing season. The flooding could delay soil warmup and affect soil properties, such as pore space and size. These factors could have indirect effects on vegetative growth.

Plates D-15 and D-16 cannot be used to assess the existing conditions or the present loss of wildlife habitat resulting from natural river flooding. Although some loss of habitat occurs because of natural flooding, it is not as significant as modified conditions would be. Also, the existing situation provides a type of habitat and community structure that is important to many forms of wildlife. Evidence supports the conclusion that natural river flooding does not produce the same effects as modified flooding from reservoir storage. The specific reason for this difference is not known, but the difference in water characteristics (temperature, oxygen concentration, etc.) between ponded and flowing water is undoubtedly a factor.

EFFECTS ON SPECIFIC TYPES

Cropland

Crops in the basin are usually short in stature and are therefore easily overtopped. Complete inundation, even for short periods, is detrimental to species that are not adapted to flooding. These graphs do not consider delays in planting caused by flooding or the possibility of planting a crop after floodwaters recede.

Oak Savannah

The oak savannah consists primarily of bur oak with upland grass species. Damage is intermediate between upland hardwoods and grassland because of the mixture of vegetative types. The upland grass would be more heavily damaged than the woody species and would be replaced by less desirable weedy species such as thistle.

Oxbow (Marsh)

This type consists of emergent and submergent vegetation and the adjacent shore vegetation. Damages are based on the death of vegetation, reduced productivity, change in area available for pond vegetation, and lack of shoreline vegetation as the pond water level recedes. Sedimentation, reduced light transmission, and lack of contact with air influence the species composition and survival of vegetation.

Streambank

The streambank is the area adjacent to the river that is flooded under natural conditions. Understory in this area is generally lacking. Ponding of water in this area would result in some loss of tree vegetation. Prolonged flooding would kill the trees and eliminate cover for wildlife. The area is similar to lowland hardwoods but with less understory.

Shrub/Swamp

Shrub/swamp is similar to lowland brush, except that it usually contains more standing water (sometimes for most of the year). In both cases, the root system of the vegetation gets aeration through small variations in topography. This type is well adapted to flooding and standing water. However, covering the soil surface or complete inundation of vegetation by water for prolonged periods diminishes habitat value.

Upland Brush

Upland brush is not subject to flooding under natural conditions and is usually relatively short (about 10 feet). Flooding would be very detrimental to this type of habitat. The cover, nesting, and food values would be destroyed in short periods of time. The frequency of inundation, which is determined by elevation, is an important factor in predicting the recovery potential and value of the type of habitat to wildlife.

Upland Hardwoods

This type is not subject to prolonged flooding. The understory is usually fairly dense if it is not heavily grazed. However, the understory, which provides much of the habitat value, does not tolerate flooding; therefore, most losses would occur with short-duration flooding. Frequent inundation would prevent the reestablishment of most tree species. Complete recovery could possibly occur in 75 years if there were no further disturbance.

Grassland

Very little information is available on grassland species. They have a wide range of flooding tolerances. Upland species are intolerant and are usually replaced by weedy species of lower habitat value, such as thistle.

Lowland Hardwoods

Lowland hardwoods are similar to streambank habitat. This type is not as frequently flooded, under natural conditions, as the streambank and has more of an understory. Impacts are greater than for the streambank because of the understory. Frequent or long-duration inundation would kill much of the woody vegetation and create mud flats or areas dominated by annual species such as smartweed, cocklebur, velvet leaf, pigweed, and others.

Lowland Brush

This type is similar to the shrub/swamp, except that it is less frequently flooded under natural conditions and does not contain as much standing water. Impacts are greater because of species composition and existing conditions.

RECOVERY

After floodwaters recede, a recovery process takes place. This process starts in an early stage of succession and has a different species composition than that of preflood conditions. The habitat value depends on the extent of flooding, the preflooding species composition, and the frequency and duration of subsequent flood events. The variables listed below would be used to predict total losses and recovery.

Habitat type	Years to total recovery	Percent recovery (100-year project life)
Upland hardwoods	75	1.3
Upland brush	15	6.7
Grassland	20	5
Lowland hardwoods	50	2
Lowland brush	10	10
Cropland	2	50
Oak savannah	40	2.5
Oxbow (marsh)	15	6.7
Streambank	50	2
Shrub/swamp	15	6.7

Major flood control reservoirs typically have dramatic effects on terrestrial vegetation, and the Ashtabula and Kindred projects would be no exception. This conclusion is based on the literature and on observations of flood control reservoirs in the northeastern United States and the Upper Midwest. The reservoirs studied exhibit a wide range of

characteristics - from great depths (e.g., 50-100 feet) of floodwater storage to small depths, from long durations of storage (e.g., from snowmelt until late August and late September) to floodwater storage of only about a week, from prairie to near-boreal forest conditions, from dry dams to wet dams with small to very large "permanent" pools, from a few tens of acres in the flood and/or "permanent" pools to many tens of thousands of acres, from watershed conditions which allow several hundreds of acre-feet of sedimentation during even the more frequent floods to conditions allowing only a thin deposition of sediment during flood events, and so on. There are also a number of studies on other pertinent vegetation flooding relationships (e.g., vegetation damage behind beaver dams and natural river flooding effects upon bottomland hardwoods in the southern United States). Unfortunately, none of the situations studied are like the study area in all the key characteristics. Also, no published review articles compare all these different conditions or present some sort of model which could be used to predict the effects of impoundments on vegetation. Furthermore, most studies have related vegetation damage only to duration and/or depth of flooding, while observations indicate that topographic conditions, frequency of storage, slackwater versus flowing water, vegetation health and maturity, phenology, and a host of other factors also dictate the degree to which vegetation will be damaged. The following paragraphs, therefore, contain only a few semiquantitative predictions on vegetation damage from Baldhill and Kindred Dams. In most cases, they represent best judgments based on the above discussion. Specific impacts would depend on reservoir operation characteristics and habitat composition at Ashtabula and Kindred. Predictions at other reservoirs would be different.

Grassland

Grassland makes up a large portion of the habitat at both the Ashtabula and Kindred sites. Most of the grassland is heavily grazed or hayed. Grazing pressure appears to be higher at the Ashtabula site.

Floodwater storage of even a few days during the growing season would be sufficient to kill the grassland sod. This impact would be most apparent in areas of upland grassland types (of both native and introduced species) as opposed to grass or graminoid types which are more adapted to wet conditions. In the grassland communities, the uppermost limit of floodwater storage during any given flood would be marked by a rather distinct line of flood-deposited debris and a conspicuous growth of taller weeds. In one observed case, the weedy growth has persisted for a few years since floodwater storage, dominated by the thistles _Sonchus_ and especially _Cirsium_, and appears rather stable.

The thistle-dominated zone of maximum floodwater storage would be most vigorous at its upper edge; hence its sharp demarcation from grassland undisturbed by floodwater storage and its value (even without accompanying debris) in marking the zone of maximum storage. The thistle-dominated zone would attenuate within a couple of vertical yards to a zone which is typified by bare ground and/or subsoil (at least until some plant litter reappears) which has a relatively sparse growth of early successional "weeds" typical of xeric (very dry) conditions (even in climates of fairly favorable evapotranspiration conditions). Below the sparse-growth, bare-soil zone would be a zone of subsoil with some woody debris and some weeds where conditions of microclimate and sustained seed retention in the subsoil would permit (e.g., behind driftwood) Below the zone would be mostly bare subsoil. These more drastic changes would be permanent for practical purposes.

This general profile drawn from the literature and observations at existing reservoirs would be applicable at most of the side slopes in the flood pool following floodwater storage. Surprisingly, there is little difference in shoreline impacts (based on observations at existing projects) between sites having an "effective fetch" of as little as 100 feet. In either case, the sod is heavily damaged, and resultant weedy plant communities are similar, other factors such as topography allowing.

The permanence of these vegetation effects on valley side slopes is of interest in evaluating impacts. No documented, directly applicable studies address this problem. However, observations at existing reservoirs suggest that the thistle-dominated zone may recover in large part within a couple decades or so through retention of the upper soil horizons and competition/succession (assuming no further disturbance from inundation). Range ecology studies of similar plant communities could perhaps refine this estimate. For the areas below the thistle-dominated zone, damage to the sod and upper soil horizons would be sufficient to set the sites back to something akin to the primary succession stage. Given the time spans involved in succession on severely degraded grassland and apparent great length of time needed to develop a typical prairie soil profile, complete recovery from a major flood may never occur before the next flood, even for extremely rare floods in the upper part of the pool area. Management practices could, of course, be used to advance recovery (or to provide another desirable plant community such as "dense nesting cover"), but such efforts are not programmed nor would they provide all the attributes of the original plant community.

Along the relatively flat valley bottom, the existing grassland community would be killed; but soil and slope-erosion characteristics are such that postflood terrestrial plant growth could be profuse (in contrast to slope areas; see the section on weed control which follows). However, in areas of more frequent water level fluctuation and sediment deposition, the substrate would be a mud flat with cracks from drying and with sparse seedlings of annual weeds or perhaps, more typically, growths of "terrestrial" algal species in wet areas. The mud-flat condition would persist for a few years, depending upon sedimentation-frequency of storage characteristics as well as the physical effects of drying and freezing. Even when moisture is adequate, other physical conditions may forestall succession. Of course, management practices could again be used.

Agricultural Land

The majority of the potentially affected agricultural land lies on the valley floor. The Soil Conservation Service has indicated that much of the valley floor in the proposed Kindred pool is "prime" farmland (the land's value derives from its general advantage as cropland because of soil and water conditions). The area around Lake Ashtabula is "prime" farmland, but the area in the proposed pool does not appear to be classified "prime".

Woodland

The woodland is probably the most valuable wildlife habitat in the basin. It is used heavily by deer and other wildlife species and provides habitat for a number of rare species. Depending on the alternative selected, about 50 to 70 percent of the woodland in the design pool would be destroyed or seriously damaged as a result of the increased elevation and duration of storage.

Even with relatively short durations of flooding, the entire forest herbaceous layer, consisting of wildflowers and other herbs and grasses, would be eliminated. The inundation impacts would depend on factors such as phenology, timing of flood, and topographic position. The subsequent flooding regime would dictate the successional patterns in the area.

Storage of floodwaters at either Ashtabula or Kindred could last for very long time periods and would destroy many acres of floodplain forest. Damage in streambank areas would in turn cause damage to the stream because much of the productivity of the stream depends on the shade, habitat, and input of organic material provided by the riparian forest.

It should be noted, for example, that in the Kindred wet-dam design pool, the approximately 5,400 acres of woodlands represent 1.4 percent of the State total of 400,000 acres and about 12 percent of the 45,500 acres of woodland and windbreaks in Richland and Ransom Counties (acreage figures based on preliminary information supplied by the U.S. Forest Service).

Some woody vegetation would be reestablished, but it would be of a type quite different from the existing floodplain forest. Re-sprouting and suckering from roots or root collars (such as occurs after logging) would be of no significance because the underground plant parts are generally killed by floodwater storage of long duration. Reestablishment from tree seed would be sporadic because of changed soil conditions and the lesser availability of tree seed once the local floodplain forest is killed. Where conditions allow (e.g., when soils are not water-logged for long periods and are not otherwise chemically or physically altered or when the upper soil horizons are not removed after the vegetation dies), the general pattern might be in the growth of dense scattered thickets of willow and cottonwood. A herbaceous and shrubby understory is essentially lacking in such stands. The stands would persist until the next equivalent flood storage, when many of them would die. In a few scattered spots, individuals of the regrowth could survive the next flood, provided their roots are not killed. Trees surviving inundation may be damaged or killed by wind-driven debris or ice, however. In some cases, only portions of the roots and crowns of existing trees would be killed, but the weakened trees would thereby be subject to an earlier death in later years because of their increased susceptibility to insect and disease attack.

There may be some opportunity to plant new trees in the affected areas, but this concept is most useful for reservoirs having storage which is not of great depth and, especially, duration. In such cases, the more successful plantings involve large specimens

with trunks several inches in diameter. The plantings would generally last only until the next flood of similar or larger magnitude because of the long durations of storage. Herbaceous and shrubby plantings would seem more practical because of their more rapid regrowth. Some tree plantings may be practical at higher elevations within the pool.

Wetlands

Wetland habitat consisting mostly of oxbows is fairly uncommon in the Kindred pool area. A fairly large acreage of marsh habitat at the upper end of Lake Ashtabula was created by the lake and sedimentation patterns. Farther upstream, oxbows are the predominant wetland feature, but are not common.

Although wetlands have a semiaquatic plant community and are subject to less drastic changes than terrestrial communities, damage caused by inundation would be significant there also. In many areas, floodwater storage would kill both emergent and submergent, perennial and annual, rooted aquatic plants through reduced light transmission, removal of contact with air, etc. Recovery could take a few years or possibly more than a decade, depending on the vegetative composition.

There would probably be some lasting effects in the wetlands, however. One possibility is a shift in species composition, even with management. For example, cattails could come back as the more vigorous *Typha angustifolia*, instead of *T. latifolia*. The significance of this change is difficult to assess. Another possibility relates to observations at an Iowa reservoir where small clumps of arrowleaf (*Sagittaria* sp.) have been present for a number of years after flood storage, but have not yet become as common as the less desirable species *Carex*, *Polygonum*, *Cyperus*, etc. Perhaps the significant accumulation of sediment and trash at the Iowa reservoir has caused a long-term adverse shift in suitability of the site for the more desirable species of aquatics such as arrowleaf. Also, site-specific differences such as soil or a source of cool fresh water would be a factor in plant distribution.

The fringe of emergent vegetation around Lake Ashtabula, although not common, is also an important marsh habitat that would be subject to damage from fluctuating water levels, increased depth and duration of flooding, and increased ice damage.

Weed Control

With the death or substantial disturbance of terrestrial plant communities from floodwater storage, conditions suited to weedy species would prevail. Studies at flood control reservoirs in Iowa and North and South Dakota have revealed a general pattern of death of desirable perennial vegetation, followed by a great increase in annual weedy species on all but the most severe sites (Stanley and Hoffman, 1974, 1975; Hoffman, 1978; Wilson and Landers, 1973).

The studies by Stanley and Hoffman and Hoffman at Lakes Oahe and Sakakawea on the Missouri River showed the projects as encouraging three species listed as noxious weeds under North Dakota law (Mitich, undated). These were field bindweed (*Convolvulus arvensis*), which covered 1 to 9 percent of Stanley and Hoffman's sample plots in the weedy floodwater storage zone around the reservoirs; field pennycress (*Thlaspi arvense*), at 2 to 6 percent; and Absinth wormwood (*Artemisia absinthium*), at less than 0.5 percent. Other weeds found in the Lakes Oahe and Sakakawea study area were:

Dock	(*Rumex crispus*)
Prickly lettuce	(*Lactuca scoriola*)
Kochia, Mexican fireweed	(*Kochia scoparia*)
Annual sunflower	(*Helianthus annuus*)
Giant ragweed	(*Ambrosia trifida*)
Russian thistle	(*Salsola kali*)
Erect knotweed	(*Polygonum erectum*)
Lambsquarters	(*Chenopodium album*)
Wild buckwheat	(*Polygonum convolvulus*)
Gumweed	(*Grindelia squarrosa*)
Wild rose	(*Rosa arkansana*)
Ragweed	(*Ambrosia artemisifolia*)
Leafy spurge	(*Euphorbia esula*)

None of the species on this list are covered by North Dakota's weed laws, but they are on the list of those species which are considered for lower scoring in North Dakota crop judging contests (Mitich, undated). At reservoirs elsewhere in the Midwest, other weeds such as Canada thistle (*Cirsium arvense*) (which is on the North Dakota list), pigweed (*Amaranthus* sp.), velvet leaf (*Abutilon theophrasti*), tickseed (*Bidens* sp.), foxtail barley (*Hordeum jubatum*), horseweed (*Conyza canadensis*), and cocklebur (*Xanthium* sp.) sometimes become quite common.

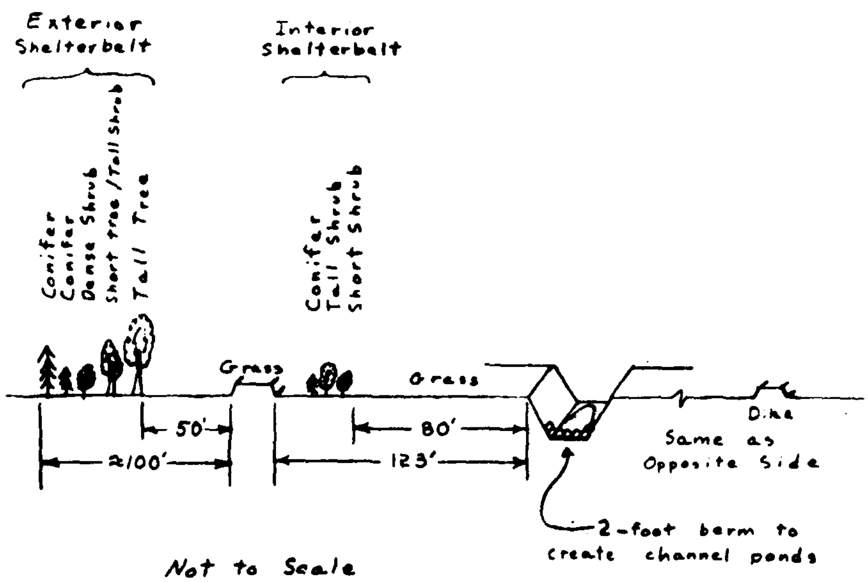
While it is not possible to predict the exact weed species or the amounts which would be present at the proposed reservoir, both Ashtabula and Kindred Dam would create weed problems. This could cause difficulties for farmers in the area who may fear that their fields would become infested with weeds. The likely result is that a weed control program would be required on project land. Of course weed control on any land on which there is only a flooding easement would remain the responsibility of the private landowner. It is also possible that farmers on land near the flood storage area may become more active in weed control to provide what they may feel is a needed margin of safety.

VEGETATION MANAGEMENT PLAN FOR LEVEES AND DIVERSION AT WEST FARGO/RIVERSIDE
by Robert Anfang, Forester, St. Paul District

Various measures could be employed in conjunction with the levee and diversion systems to help control snow drifting and erosion and to contribute to environmertal and aesthetic benefits.

SHELTERBELTS

A major component of the plan would be shelterbelts. The purpose of shelterbelts is to control the drifting of snow and reduce the likelihood of snow accumulating in the channel. Shelterbelts also reduce soil erosion and provide wildlife and aesthetic benefits in the urban environment. Two alternative shelterbelt planting schemes are shown in the sketch below.



Exterior shelterbelts would be planted parallel to the river and their inner edge should be no less than 150 feet from the top of the channel and as far as 500 feet from the channel. Optimally, shelterbelts should be four or more rows wide, planted on both sides of the channel to obtain maximum benefits.

Within the shelterbelt, rows should be planted 15 feet apart. Plantings within the rows should be 3 to 5 feet apart in the shrub row, 5 to 8 feet apart in the tall shrub/short tree row, and 10 feet apart in the tree rows. Such spacing will provide an effective barrier against windblown snow, yet eliminate most of the natural pruning which occurs on plantings that are too close together.

Plantings would be arranged so that the outer row (farthest from the channel) would be a tall conifer such as Scotch pine (*Pinus sylvestris*) or blue spruce (*Picea pungens*). The second row would be a short conifer such as red cedar (*Juniperus virginiana*). The third row would be composed of a combination of dense shrub species, including Allegheny blackberry (*Rubus allegheniensis*), buffaloberry (*Shepherdia argentea*), chokecherry (*Prunus virginiana*), honeysuckle (*Lonicera tartariea*), and multiflora rose (*Rosa multiflora*). The fourth row would consist of tall shrubs or short trees including Russian olive (*Elaeagnus angustifolia*), American plum (*Prunus americana*), and lilac (*Syringa vulgaris*). The fifth row would consist of tall trees including green ash (*Fraxinus pennsylvanica*), bur oak (*Quercus macrocarpa*) or cottonwood (*Populus deltoides*).

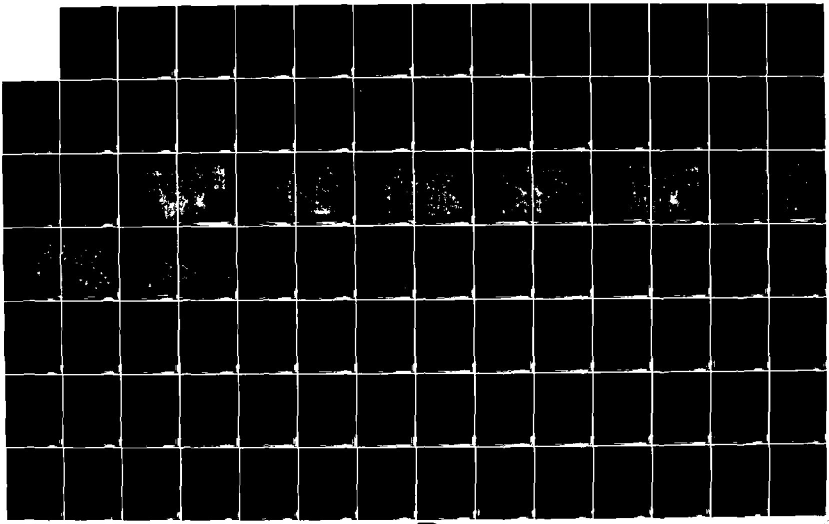
The shrub and short deciduous tree rows would be planted in groups of five while the conifer and tall deciduous tree rows would be a continuous species composition.

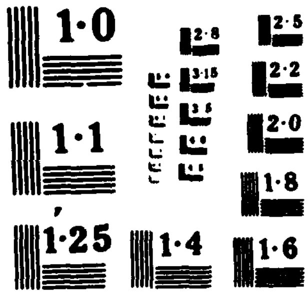
Such a planting scheme maximizes the protective benefits of the belt in addition to reducing the possibility that a disease affecting a single species may destroy the belt. Species composition would provide wildlife food and cover and aesthetic values in an area where agricultural clearing and urbanization has destroyed most of the natural habitat.

In addition, or as an alternative to the five-row exterior shelterbelt, a tall shrub shelterbelt could be placed on the interior of the leveed berm.

AD-A147 702 GENERAL REEVALUATION AND ENVIRONMENTAL IMPACT STATEMENT FOR FLOOD CONTROL..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT JAN 84 2/6

UNCLASSIFIED F/G 13/2 NL

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3·15

This interior shelterbelt would be almost as effective as the exterior shelterbelt. Consisting of a three-row design, the interior shelterbelt should be planted at least 80 feet from the top of the channel, and at least 10 feet from the toe of the berm. Rows within this shelterbelt should be 15 feet apart while the plants within rows should be about 3 to 5 feet apart. The row farthest from the channel would be planted with eastern red cedar. The middle row could consist of tall shrubs, such as chokecherry, honeysuckle, and lilac. The row closest to the channel could consist of sumac, juneberry, and dogwood. Plants in these last two shrub rows would be arranged in species groups of 25.

The exterior shelterbelt has the advantages of being longer-lived; and, in the long run, it would probably be more effective against snow drifting. In addition, wildlife and aesthetic benefits would be greater with the exterior shelterbelt. This shelterbelt would require about 10 years before it becomes fully effective.

The advantages of the interior shelterbelt are that no additional land would be required and that the shelterbelt would be effective sooner (in approximately 5 years).

It may be desirable to have both the exterior and interior shelterbelts. The interior one would provide additional wildlife benefits and would form backup to the exterior shelterbelt for snow drifting. It would act as freeboard for the snow control.

GRASS SEEDING

The remainder of the leveed area and the dikes would be planted with a mixture of perennial ryegrass (Lolium perenne), red fescue (Festuca rubra), and bluegrass (Poa sp.). When the grass is 8 inches in height, the dikes would be mowed no shorter than 4 inches in height. Mowing should not occur before 15 June or after 1 September.

The leveed areas would be grassed with a mixture of perennial ryegrass, red fescue, bluegrass, rye (Elymus sp.), and sorghum (Sorghum sp.). This area would be mowed no shorter than 8 inches, according to a schedule similar to

that above. The channel itself would be entirely grassed to control erosion and to provide aesthetic and wildlife benefits. Species composition would include rye, fescue, reed canary grass, smartweed, sedge, and similar species. If the channel has to be mowed, it should be cut no shorter than 10 inches and not before 15 June or after 1 September.

Table D-18 can be used to estimate the cost of various vegetation management alternatives for the levee and diversion around West Fargo. For example, one possible vegetation management plan for the diversion channel is described below. On the west side of the channel from Main Street north to the Sheyenne River, an exterior shelterbelt, approximately 8,000 feet long, could be established. An interior shelterbelt could be constructed on the east side of the channel for a distance of about 14,000 feet from 13th Avenue north to the Sheyenne River. The remaining area of the diversion channel, overbank, and dike would be seeded to grasses. The overall length of the proposed diversion channel is 22,000 feet. The estimated cost of this plan would be $416,000, with the following distribution of costs: exterior shelterbelt portion $261,000 (8 X $32,700), interior shelterbelt portion $68,600 (14 X $4,900), and grass seeding $85,800 (22 X $3,900).

CHANNEL PONDS

In addition to the planting plan, structures could be installed to create a pond 1 to 2 feet deep at two places in the diversion channel. Located at the outlet of the diversion channel, one structure would impound water back to about the railroad bridge. The other structure, located near 13th Avenue, would back water up for about 5,000 feet.

To minimize mosquito problems, the water level in these pools should be kept as constant as possible. In addition, a continuous flow of fresh water through the pools would be desirable. The area around the pools could be seeded with smartweed, cattail, prairie cordgrass, rye grass, and similar species. Wildlife and aesthetic benefits would accrue through the creation of aquatic habitat for birds.

Because of the problems associated with mosquito production and the possibility that mosquito breeding habitat would be enhanced, this measure was not considered further and was eliminated from the channel management plan.

Table D-18 Species composition and planting cost estimates for channel management plans for the levee and diversion structure.(1)

Species	Exterior Shelterbelt: Plant Spacing (Feet)	Plants Per 1,000 Ft.	Cost Per 1,000 Plants	Cost Per 1,000 Feet	Cost Per 1,000 Feet Including $1.50/Plant Planting Cost	Interior Shelterbelt: Plant Spacing (Feet)	Plants Per 1,000 Ft.	Cost Per 1,000 Plants	Cost Per 1,000 Feet	Cost Per 1,000 Feet Including $1.50/Plant Planting Cost
Conifer						10	100	250	25	180
Red cedar	10	100	250	25	180					
Blue spruce	10	100	500	50	200					
Short shrub (blackberry, sumac, juneberry, dogwood, etc.)	4	250	250	63	440	4	250	250	25	400
Tall shrub/short tree (lilac, honeysuckle, chokecherry, Russian olive, etc.)	7	143	250	36	250					
Tall shrub (chokecherry, lilac, honeysuckle)						4	250	250	25	400
Tall tree (green ash, cottonwood)	10	100	180	18	170					
Sub-Total					1300(2)					1000(2)
Additional Land Cost Per 1,000 Feet of Exterior Shelterbelt			North of Main Street		27,500(3)					
			South of Main Street		6,900(4)					
Cost of Grass Seeding Per 1,000 Lineal Feet of Leveed Area					3,900(5)					3,900(5)
			North of Main Street		32,700					
			South of Main Street		12,100					
Grand Total					44,800					4,900

(1) Costs are based on the area from the centerline of the channel to the outer edge of the levee or exterior shelterbelt, as appropriate. Costs are rounded to indicate estimates.

(2) Based on 1981 planting stock costs from the North Dakota Soil Conservation Service. Planting costs obtained from "Cost Data for Landscape Construction," 1980.

(3) Based on requirement of an additional 2.3 acres of land every 1,000 lineal feet at a cost of $12,000 per acre.

(4) Based on requirement of an additional 2.3 acres of land every 1,000 lineal feet at a cost of $3,000 per acre.

(5) Based on seeding 4.6 acres on one side of the channel every 1,000 lineal feet at a cost of $850 per acre.

SUMMARY

The vegetation management measures described here would reduce erosion potential and prevent snow from drifting into the channel. In addition, the shelterbelts and grass plantings would produce wildlife benefits in the urban environment and increase the aesthetic value and overall appearance of the diversion channel and surrounding area. For these reasons, shelterbelts and grass plantings should be considered at all diversion alternatives. The benefits attributable to these measures are considerable.

ENDANGERED SPECIES COORDINATION

Coordination with the U.S. Fish and Wildlife Service included the exchange of correspondence and related assessments and evaluations to provide compliance with the Endangered Species Act of 1973, as amended. The presence of any federally listed threatened or endangered species in the project area and any potential impacts of the proposed projects on these species were assessed. Copies of this correspondence, including the endangered species assessment prepared by the Corps, are reproduced on the following pages.

22 March 1979

Mr. Harvey Willoughby
Regional Director
Fish and Wildlife Service
U.S. Department of the Interior
P.O. Box 25486
10597 West 6th Avenue
Denver, Colorado 80225

Dear Mr. Willoughby:

This is in response to the 11 January 1979 letter from Mr. William [illegible] of your Bismarck, North Dakota, Area Office concerning implementation of Section 7(c) of the Endangered Species Act Amendments of 1978 (P.L. 95-632). In compliance with this act, we intend to request information on the presence of threatened or endangered species on those projects for which an environmental impact statement (EIS) or assessment (EA) is currently being prepared or where a statement or assessment has been completed but construction has not been initiated.

At this time, we request that you provide the required information on the following projects:

1. Souris River and Tributaries, North Dakota (Burlington Dam).

2. Sheyenne River, North Dakota.

3. [illegible], North Dakota.

Requests for information on threatened or endangered species will be deferred to a later date for the following projects until more detailed information concerning project alternatives and their impacts is developed:

1. Red River of the North, Goose River, North Dakota.

2. Red River of the North, Grand Forks-East Grand Forks Urban Study, Minnesota and North Dakota.

3. Pembilier Reservoir, North Dakota.

4. Red River of the North, Mainstem Study, Minnesota and North Dakota.

5. Upper Minnesota River Subbasin Study, Minnesota and South Dakota.

6. Maple River, North Dakota.

If you have any questions, please contact Mr. Robbin Blackman of the Environmental Resources Branch at FTS 725-7233.

Sincerely,

ROGER C. [illegible]
Chief, Engineering Division

CF:
Mr. William [illegible]

United States Department of the Interior

FISH AND WILDLIFE SERVICE

MAILING ADDRESS [illegible]

STREET LOCATION
134 Union Blvd
Lakewood, Colorado 80228

[illegible]
Rivers & Enderlin

MAR [illegible] 1979

Mr. Roger G. Fast
Chief, Engineering Division
Department of the Army
St. Paul District, Corps of Engineers
1135 U.S. Post Office and Custom House
St. Paul, Minnesota 5[illegible]101

Dear Mr. Fast:

The following listed and proposed species may be in the project areas mentioned in your letter of March 12, 1979:

1. Souris River and Tributaries, North Dakota
   Listed: whooping crane, peregrine falcon, and bald eagle
   Proposed: Dakota skipper

2. Sheyenne River, North Dakota
   Listed: bald eagle and peregrine falcon
   Proposed: Dakota skipper

3. Enderlin, North Dakota
   Listed: bald eagle and peregrine falcon
   Proposed: Dakota skipper

Please refer to our memorandum of February 21, 1979, describing the next step in the consultation process.

Sincerely yours,

James C. Gritman

JAMES C. GRITMAN
Acting Regional Director

DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

[illegible]
[illegible]
[illegible]

8 October 1980

Mr. Gilbert Key
Area Manager
U.S. Fish and Wildlife Service
P.O. Box 1897
Bismarck, North Dakota 58501

Dear Mr. Key:

On 28 March 1979 we received a letter from your Regional Office (Reference Number FA/SE/CPE--Souris and Sheyenne Rivers and Enderlin) listing endangered species which could occur in the Sheyenne River, North Dakota Flood Control Study area. We were unable to meet the 180-day schedule for the submittal of the assessment and received verbal approval from the Regional Office to submit the document when our studies were completed. In accordance with the Endangered Species Act of 1973, as amended, the endangered species assessment and a Stage 2 Documentation Report for the Sheyenne River Flood Control Study are inclosed. As requested in subsequent correspondence, we are submitting these documents to your office for review rather than the Regional Office.

If you have any questions or require additional information, please contact Mr. Robbin Blackman of the Environmental Resources Branch at FTS 725-7233. Thank you for your cooperation.

Sincerely,

PETER A. FISCHER
Chief, Engineering Division

2 Incl
As stated

ENDANGERED SPECIES ASSESSMENT
SHEYENNE RIVER FLOOD CONTROL
NORTH DAKOTA

1.00 PROJECT DESCRIPTION

LOCATION

1.01 The Sheyenne River is located in east central North Dakota. It originates northeast of Bismarck in Sheridan County and flows east through Wells, Benson, Eddy, and Nelson Counties; south through Griggs, Barnes, and Ransom Counties; then north and east through Richland and Cass Counties where it empties into the Red River of the North about 15 miles north of Fargo, North Dakota. The reach included in this study begins approximately 10 miles north of Cooperstown and continues downstream to its mouth at the Red River of the North.

PROJECT AUTHORIZATION AND PURPOSE

1.02 The Kindred Lake Project was authorized by the Flood Control Act of 1970 (P.L. 91-611). The Kindred Lake restudy, completed in June 1974, addressed the effects of the project on groundwater levels, total dissolved solids concentrations, and shoreline erosion. The Phase I General Design Memorandum studies, which included a complete reformulation of alternatives to the authorized Kindred Lake project, were initiated in February 1976. The name of the project has been changed from the Kindred Lake project to the Sheyenne River Flood Control project. The authorized project includes a multipurpose impoundment for purposes of flood control, water quality control, recreation, and fish and wildlife. The reformulation studies address all of these purposes as well as that of water supply.

DESCRIPTION OF PROPOSED ALTERNATIVES

1.03 A detailed description of alternatives is presented in the Stage II report of the Phase I General Design Memorandum. (A copy of the Stage II report is enclosed with this assessment.) The alternatives considered include the following:

a. Two major diversions to the Wild Rice River at mile 54 and 65 of the Sheyenne River. Both diversions are located between Horace and Kindred and run in an easterly direction until they reach the Wild Rice River.

b. Two Sheyenne River diversions, one parallel to the river starting at mile 42, circling West Fargo on the west and rejoining the river at mile 24. The other diversion basically bypasses West Fargo beginning at mile 30 and rejoins the river at mile 24.

c. A reservoir located about 5 miles upstream of Kindred, North Dakota, in Richland and Ransom Counties.

d. Alternatives involving raising Baldhill Dam to increase the flood control storage capacity of the existing dam, which is located about 15 miles upstream of Valley City, North Dakota, in Barnes and Griggs County.

e. Two tributary dams, one at river mile 150 on Dead Colt Creek, about 5 miles southeast of Lisbon, and/or one at river mile 158 on Timber Coulee, about 1 mile south of Lisbon.

f. Using drained wetlands between Kindred and Valley City, North Dakota, as temporary storage areas for floodwaters. In addition, floodwaters would be temporarily stored in draws and valleys, drains would be plugged, and storage in existing wetlands would be increased.

g. Channelization (widening, deepening, and straightening) of the Sheyenne River between Kindred and West Fargo.

h. Placing ring levees around farmsteads and residences from Kindred to Horace, and from West Fargo to the mouth of the Sheyenne River.

2.00 EXISTING ENVIRONMENTAL SETTING

2.01 More than 70 percent of the land in the Sheyenne basin is used for agricultural purposes. However, even with the predominant agricultural use, it is one of the prime wooded valleys and grassland areas in eastern North Dakota. The Sheyenne River flows through the glacial till in the upper and middle reaches, through sand deposits in the Sheyenne delta of the lower basin, and finally through the extremely flat clay deposits of the glacial Lake Agassiz basin.

2.02 The diversion alternatives are located in the intensively cultivated Lake Agassiz basin and in general would follow existing drainage ditches, natural drainages, or cross-cultivated agricultural lands. Woodlands would be affected only in areas where the diversion leaves and enters the rivers.

2.03 The Kindred Reservoir would be located in the heavily wooded valley between Kindred and Anselm, North Dakota. Some grassland areas, most of which are located in the Sheyenne National Grasslands and are generally managed for domestic livestock grazing, would also be affected. Outside of the valley proper, agricultural use predominates.

2.04 The alternative of increasing the floodwater storage of Baldhill Dam (Lake Ashtabula) would affect grazed grassland around the lake and grazed woodlands and cropland upstream of the existing reservoir. Agricultural use is predominant in the valley.

2.05 Channelization would involve the lower 35 miles of the river located in the glacial Lake Agassiz basin. The topography is very flat and the land is heavily used for agriculture. The only remaining woodlands in the glacial lake basin are almost exclusively located along the riverbanks.

2.06 The tributary dams would be located in the Sheyenne delta and the Drift Prairie areas. Although the land in the vicinity of the tributary damsites is predominantly grassland, some woodland or shrubland is also present.

2.07 The alternative of restoring drained wetlands or increasing the c city of existing wetlands involves the area between Kindred and Baldh Dam. The wetlands have usually been drained for agricultural purpos and are now being used for cropland or grazing land. Agricultural l use is predominant in the surrounding areas.

3.00 IMPACTS OF ALTERNATIVES ON THREATENED AND ENDANGERED SPECIES

3.01 A letter from the U.S. Fish and Wildlife Service dated 28 March 1979 stated that the endangered bald eagle (*Haliaeetus leucocephalus*, Linnaeus) and peregrine falcon (*Falco peregrinus*, Tunstall), and the proposed Dakota skipper butterfly (*Hesperia dacotae*, Skinner) may be in the project area. The following is an assessment of potential impacts on these species in the project area.

Bald Eagle

3.02 According to Stewart (1975), no bald eagle nests have been recorded in the Sheyenne basin since 1950. During the 1800's, breeding populations occurred regularly along the Red River and in the vicinity of Devils Lake. The last active nest was seen in the Devils Lake area in 1923. Bald eagles were frequent visitors and several nests were seen along the Red River between Fargo and Pembina in 1873. The only recent breeding record for the bald eagle in North Dakota was in 1975, when a breeding pair and one young bird were seen in the western part of the State, near the Missouri River in McLean County (Stewart, 1975).

3.03 The bald eagle is currently a "casual" visitor during migration and winter in the Sheyenne basin. The basin is slightly beyond its usual seasonal range but it could be expected to be observed a few times (Wiehe, I.M. and J.F. Cassel, 1977).

3.04 According to the North Dakota Game and Fish Department, the bald eagle does not nest or winter in the State as far east as the lower Sheyenne River. It is possible that the eagle does migrate through the area. (S. Kohn, personal communication, July 1979) Similarly, Dr. James Grier of North Dakota State University has indicated that there have been no recent records of bald eagles nesting in the Sheyenne basin. They may, however, overwinter near open waters below dams and migrate through the basin. (J. Grier, personal communication, July 1979)

3.05 In summary, the bald eagle has not nested in the Sheyenne basin since 1950 and is only a "casual" visitor during winter and migration. The major Sheyenne basin flood control alternatives would have little or no effect on the continued existence of the bald eagle.

Peregrine Falcon

3.06 It would appear that breeding populations of the peregrine falcon have been completely extirpated from North Dakota. No breeding records have been reported since 1954. During the 1800's and early 1900's a few scattered pairs were observed regularly, chiefly on the little Missouri Slope in the western part of the State. There is no record of the presence of the peregrine falcon in the Sheyenne basin (Stewart, 1975).

3.07 The peregrine falcon may be an "accidental" visitor to the basin during migration and in winter. However, the Sheyenne basin is well beyond the falcon's usual seasonal range and only one or two sightings could be expected to occur in the area. (Wiehe and Cassel, 1977.)

3.08 The State Game and Fish Department has recorded no instances of nesting or wintering of the peregrine falcon in the Sheyenne basin. It is even doubtful that the falcon migrates through the area (records of migration are not kept by the State). (S. Kohn, personal communication, July 1979) Records of the North Dakota State University indicate no reported nesting or wintering of the falcon in the basin. There may be some migration through the basin in fall or spring but this area is not critical habitat. (J. Grier, personal communication, July 1979)

3.09 In summary, breeding populations of the peregrine falcon have probably been extirpated from North Dakota and the bird is only an accidental visitor in the Sheyenne basin. Therefore, Sheyenne River flood control alternatives would have no effect on the continued existence of the peregrine falcon.

Dakota Skipper Butterfly

3.10 The Dakota skipper butterfly originally occurred from southern Manitoba, Canada, south through North Dakota, South Dakota, Minnesota, Iowa, and Illinois. It is now apparently extirpated from Manitoba and Illinois, while occurrence in the remainder of its range is reduced. No critical

habitat is listed for North Dakota, but portions of Lincoln, Stearns, and Clay Counties in Minnesota have been proposed for listing. (Federal Register, 3 July 1978)

3.11 McCabe and Post (1971) have reported that the Dakota skipper occurs on both high, dry, virgin prairies and low, moist, virgin prairies and is strongly associated with undisturbed prairie areas along shorelines of glacial lakes such as Agassiz and Souris. The species recedes quickly at the lightest grazing pressure. McCabe and Post reported that an ungrazed portion of virgin prairie in the Sheyenne National Grasslands, considered to be the best area for Dakota skipper in the State, produced numerous skippers, until someone planted a half-block of alfalfa in the area.

3.12 Areas where Dakota skippers have been found in the Sheyenne basin are: McLeod prairie (T 134 N. R. 53 W. S.8NE¼) and Mirror Pools (T.136 N. R. 53 W. S. 36 SE¼ and T. 135 N. R. 52 W. S.4SW¼). (McCabe and Post 1977)

3.13 In a personal communication in August 1979, Dr. Edward Balsbaugh of North Dakota State University said he was not aware of sightings of the Dakota skipper other than those described above by McCabe and Post (1977).

3.14 None of the flood control alternatives would affect the McLeod prairie area. However, portions of both quarter sections at Mirror Pools would be affected by permanent pools and flood pools of the Kindred Dam alternative. In addition, preliminary results of a study sponsored by the Corps of Engineers indicate that a permanent pool at Kindred would raise groundwater levels. The effects of these raises have not been fully evaluated; however, it appears that they would cause some grassland areas to be converted to wetland (sedge) vegetation and open water. These changes would be detrimental to the Dakota skipper butterfly.

3.15 The U.S. Fish and Wildlife Service, Bismarck Area Office, obtained the following locations of sightings of the Dakota skipper butterfly from Dr. McCabe (in addition to the areas listed previously): Richland County (T 136 N. R. 51 W. S24 NE¼ and T. 136 N. R. 51 W. S35 W½) and Ransom County (T. 134 N. R. 53 W. S9 NW¼). (Cernohous, personal communication, July 1979) The area in Ransom County would not be affected by the flood control alternatives. Both areas in Richland County could be affected through potential groundwater level raises and associated vegetation changes.

3.16 Dr. Tim McCabe also notified the Corps of Engineers of the above sightings (see attached letters; McCabe, personal communications, July and August 1979) and an additional area in Griggs County (T. 147 N. R. 60 W. S16 NW¼). The area in Griggs County would not be affected by any of the Sheyenne flood control alternatives.

Dr. McCabe pointed out that water near or at the surface for even 1 or 2 days can kill the overwintering larvae of the butterfly. Changes to vegetation resulting from groundwater level raises would also be detrimental to the butterfly because of the rather restricted preferences of the butterfly. Even subtle changes could be adverse. The potential danger of fungus infections, a major cause of death for the butterfly, could be increased if humidity and moisture levels on the site increased because of water levels. (McCabe, personal communication, 1979)

3.17 In summary, the Dakota skipper butterfly is present in a number of areas in the Sheyenne basin, many of which would be adversely affected by the Kindred Dam alternative. As a result, the Kindred Dam alternative could affect future populations of the Dakota skipper butterfly in the Sheyenne delta area of North Dakota.

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THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT
ALBANY, NEW YORK 12224

NEW YORK STATE MUSEUM AND SCIENCE SERVICE

BIOLOGICAL SURVEY

29 July 1979

Mr. Bob Anfang
St. Paul District Core of Engineers
1135 U.S. P.O.
St. Paul, Minnesota 55101

Dear Mr. Anfang:

A week ago we had a telephone conversation regarding the Dakota Skipper and the proposed Kindred Dam site in Richland County, North Dakota.

I did not stop in to see Bob Riddle and Keith Roland with the Forest Service in Lisbon, but I was able to do some collecting in Richland County. I found the skipper on two patches of prairie very near the proposed dam site. The legal descriptions follow:

T136N R51W S24 NE$\frac{1}{4}$ [4 mi SSW Kindred].
T136N R51W S35 W1/2 [6 mi SSW Kindred].

I visited these areas quite late in the flight period of the skipper and am not able to give a good estimate of population size although at the second locality I sighted several males in an hour (only a single male observed at the first site).

Proper soil conditions exist through much of the area and my time was too limited for an intensive search, but I would expect to find it in other places where hayed prairies remain, including the north side of the Sheyenne River.

Overall, there appear to be scattered colonies in four places in the state. This may represent past distributional patterns that have since become disrupted by intensive agriculture. These centers encompass Richland-Ransom Counties, Sargent, Eddy-Griggs, and McHenry-Bottineau Counties.

Feel free to write if you have additional questions. Sometime between now and November I will put together ten copies of my report for the Reclamation Bureau. It will be more detailed and should answer any remaining questions.

Sincerely,

Tim L. McCabe

Tim L. McCabe
Biological Survey

THE UNIVERSITY OF THE STATE OF NEW YORK
THE STATE EDUCATION DEPARTMENT
ALBANY, NEW YORK 12224

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2 August 1979

Mr. Richard McCabe
Bureau of Reclamation
304 East Broadway
Bismarck, North Dakota 58501

Dear Richard:

You indicated in our recent conversation that the question of "Threatened Status" for Hesperia dacotae is now being re-considered and you asked me to comment on its status based on what I have observed having completed a survey for the skipper for the Reclamation Bureau.

Hesperia dacotae is presently known to occur in 29 different sites ranging from Manitoba to Iowa (including eastern North and South Dakota and western Minnesota). Only 4 colonies that I am aware of have a substantial and stable population. At least 2 of these 4 are on less than a quarter section of land. Many of the total sites are known from the capture of 1-3 specimens. Several of these sites need verification and many additional localities remain to be discovered although the entire geographical limits are fairly well established. North Dakota has 12 of these 29 sites. Many of these consist of sightings of 2 or 3 specimens. These may represent wandering individuals (especially when male) from a nearby, but unlocated population, or else they may be remnants from earlier times when more habitat was available.

Some of the localities in North Dakota are in danger of being eliminated by grazing or plowing. One locality is below a proposed Army Core dam on the Sheyenne River and one other is within the confines of the Garrison project. Most of the sites are on private farmlands and are not immediately threatened. These areas are hayed regularly and this is maintaining the correct conditions for the skipper. Any time land ownership changes hands, land use patterns can be altered. The desirable prairies in Minnesota are threatened (one by gravel extraction, the other through grazing pressure). No recent records are available for Manitoba or Iowa. Illinois has some pre-1900 records that need verification (may have been misidentifications).

When the proper conditions are present (hayed virgin prairies on gravel soils), the skipper is very abundant and collectors certainly present no threat to the species at this time. Habitat procurement and maintainence are of a more pressing nature. If known locations can be procured through mitigation pacts involving current and future projects (such as the Garrison Diversion), I see this as more desirable than listing them as Threatened Species. Although less acreages are available as breeding sites for this species than are available for many species now enjoying endangered status, this is due in part to the

limited overall range of the insect as well as narrow habitat requirements within this limited range.

Many desirable bird species (Baird's Sparrow, Chestnut-collared Longspur, Sprague's Pipit) and plant species (Habenaria leucophaea, Cypripedium candidum) occur on these same prairies. Very few pristine prairies remain and it is these specialized prairies that are truly threatened. With the preservation of several of these prairies (at least two have already been preserved) the Dakota Skipper will not require Threatened Status. If such standing is the only way this type of prairie will receive protection, then that is a desirable goal for the sake of a number of plant and animal species as well as the skipper. The Dakota Skipper is just one insect species known to inhabit and require these prairies; our knowledge of this species is still fragmentary, but rather complete when compared to the many other insect species that undoubtedly require similar conditions.

When considering insect species we must not think in terms of breeding pairs, but in terms of breeding sites. A flood or fire or similar disaster (if it occurs at a critical stage in the life cycle) can eliminate a population and not just for one breeding season, but forever. Reintroducing the skipper on suitable prairies has not been attempted, but should be possible. Reestablishing an entire prairie is much more complex.

We are dealing with a few small tracts of prairie which, for the most part, are miles from the nearest population centers. The type of protection they need is to limit their use to what they are presently being used for, hay. The Dakota Skipper is not forseeably threatened in several of the known sites. I would like to see its haunts protected with a minimum of litigation.

Sincerely,

Timothy L. McCabe, Ph.D.
Curator of the Insects
New York State Museum
Albany, New York 12230

United States Department of the Interior
FISH AND WILDLIFE SERVICE
AREA OFFICE–NORTH DAKOTA
1500 CAPITOL AVENUE
P.O. BOX 1897
BISMARCK, NORTH DAKOTA 58501

OCT 17 1980

Mr. Peter A. Fischer
Chief, Engineering Division
St. Paul District, Corps of Engineers
1135 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

Dear Mr. Fischer:

This responds to your letter of October 8, 1980, concerning endangered species in the Sheyenne River, North Dakota, Flood Control Study area.

We concur with your biological assessment that the proposed project should have no adverse affects on the continued existence of the peregrine falcon and bald eagle or their critical habitat. We also agree with your conclusion that the Dakota Skipper butterfly would likely be adversely affected by the Kindred Dam alternative. The Dakota Skipper, however, has been removed from the proposed species list, at least temporarily. The species will likely be reviewed again in the future and may again be proposed. In that event, the species should again be considered in any evaluation of the Sheyenne River Study.

Thank you for your cooperation in our mutual responsibilities toward endangered species.

Sincerely yours,

Gilbert E. Key
Area Manager

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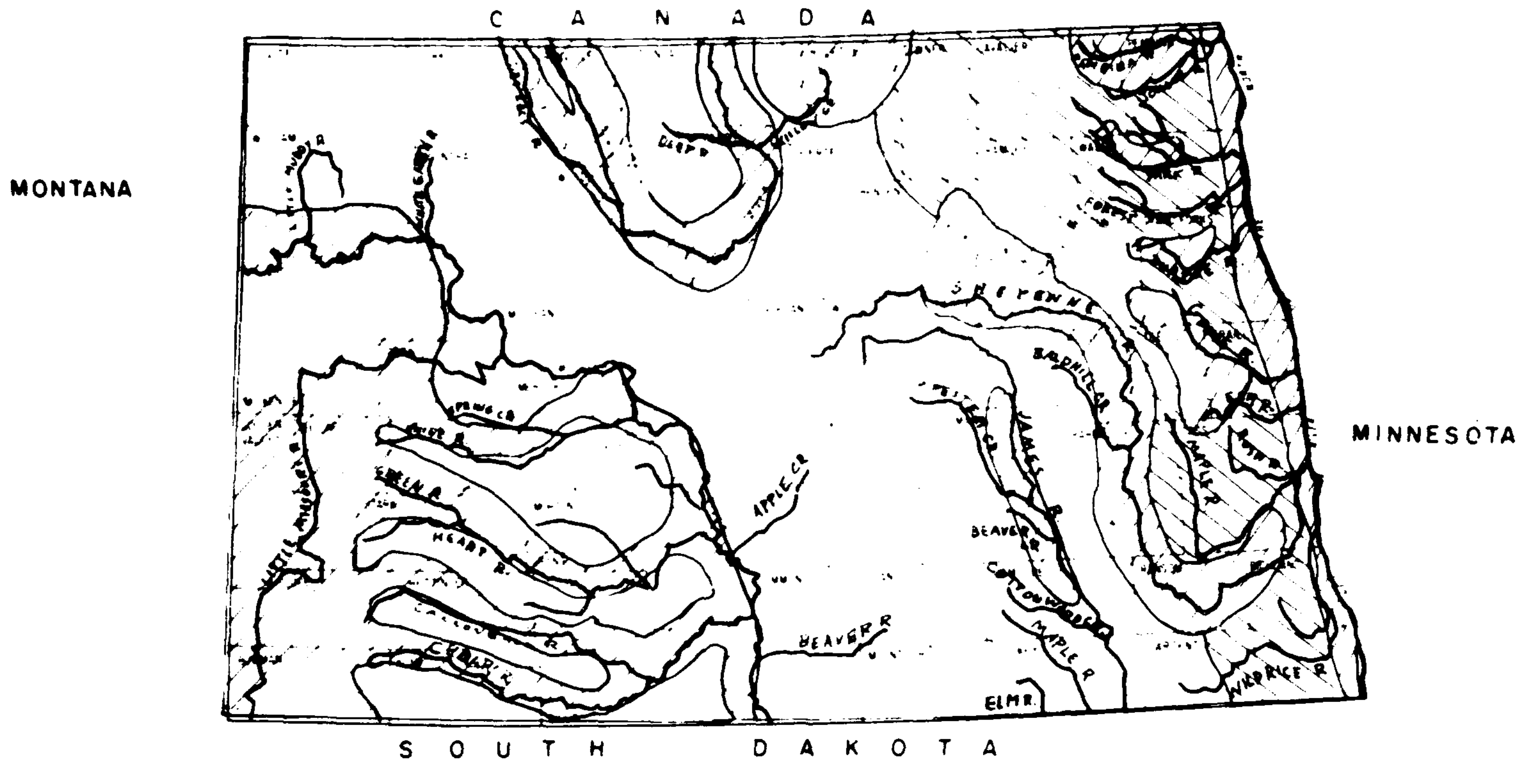


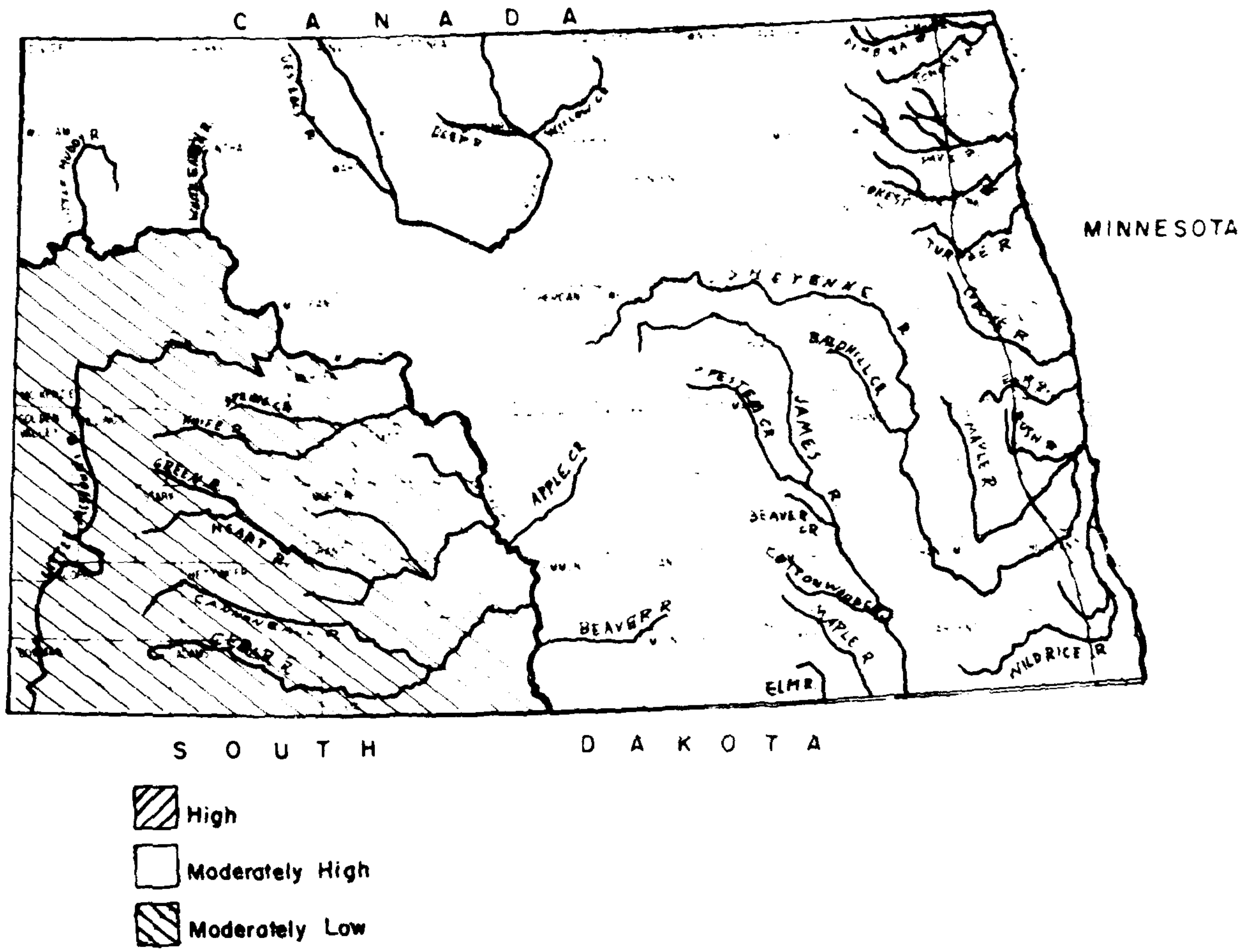
High (more than 1.5 deer/mi²)

Medium (0.5 to 1.5 deer/mi²)

Low (less than 0.5 deer/mi²)

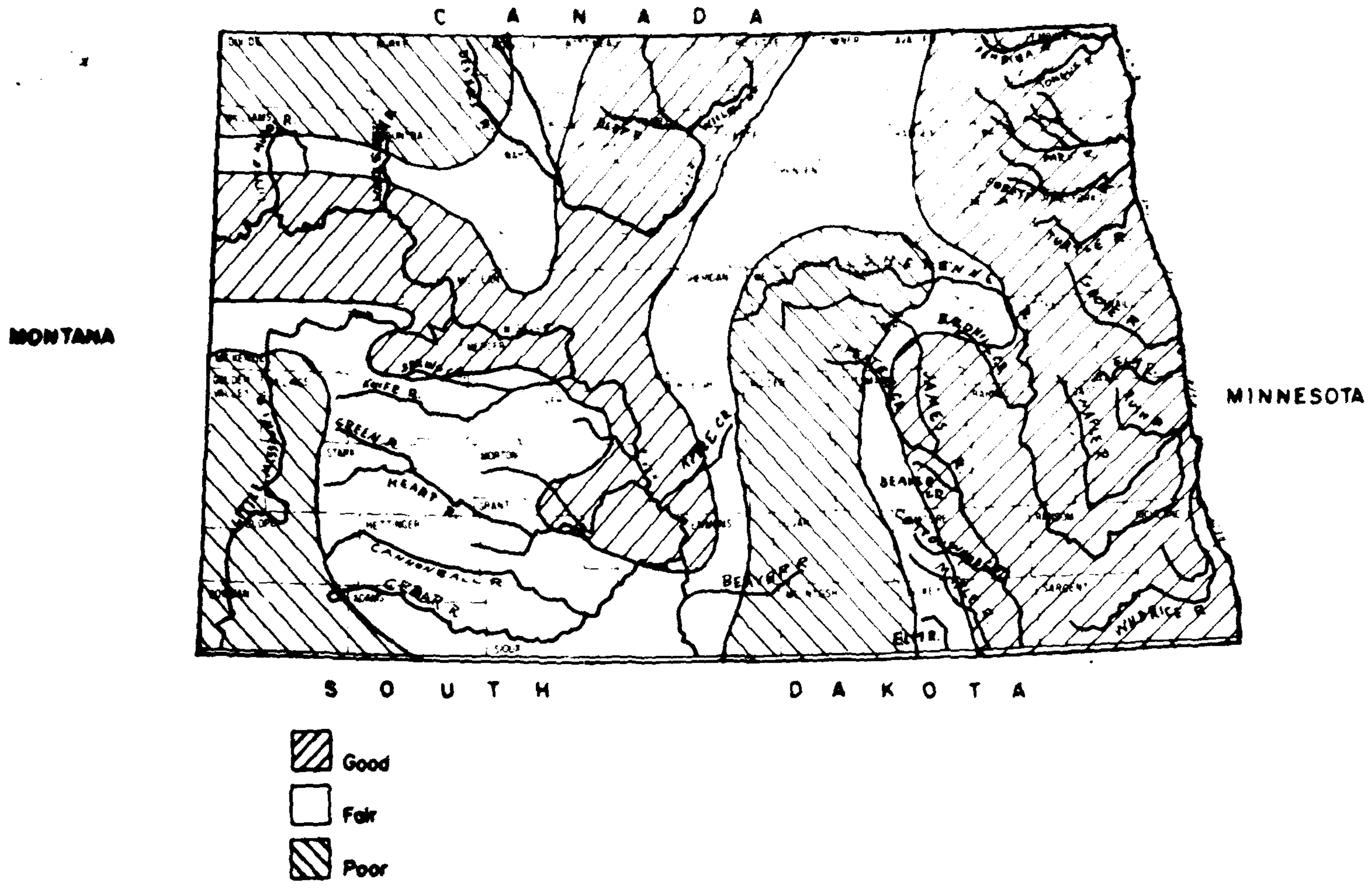
WHITETAILED-DEER POPULATION DENSITY

LATE D-1



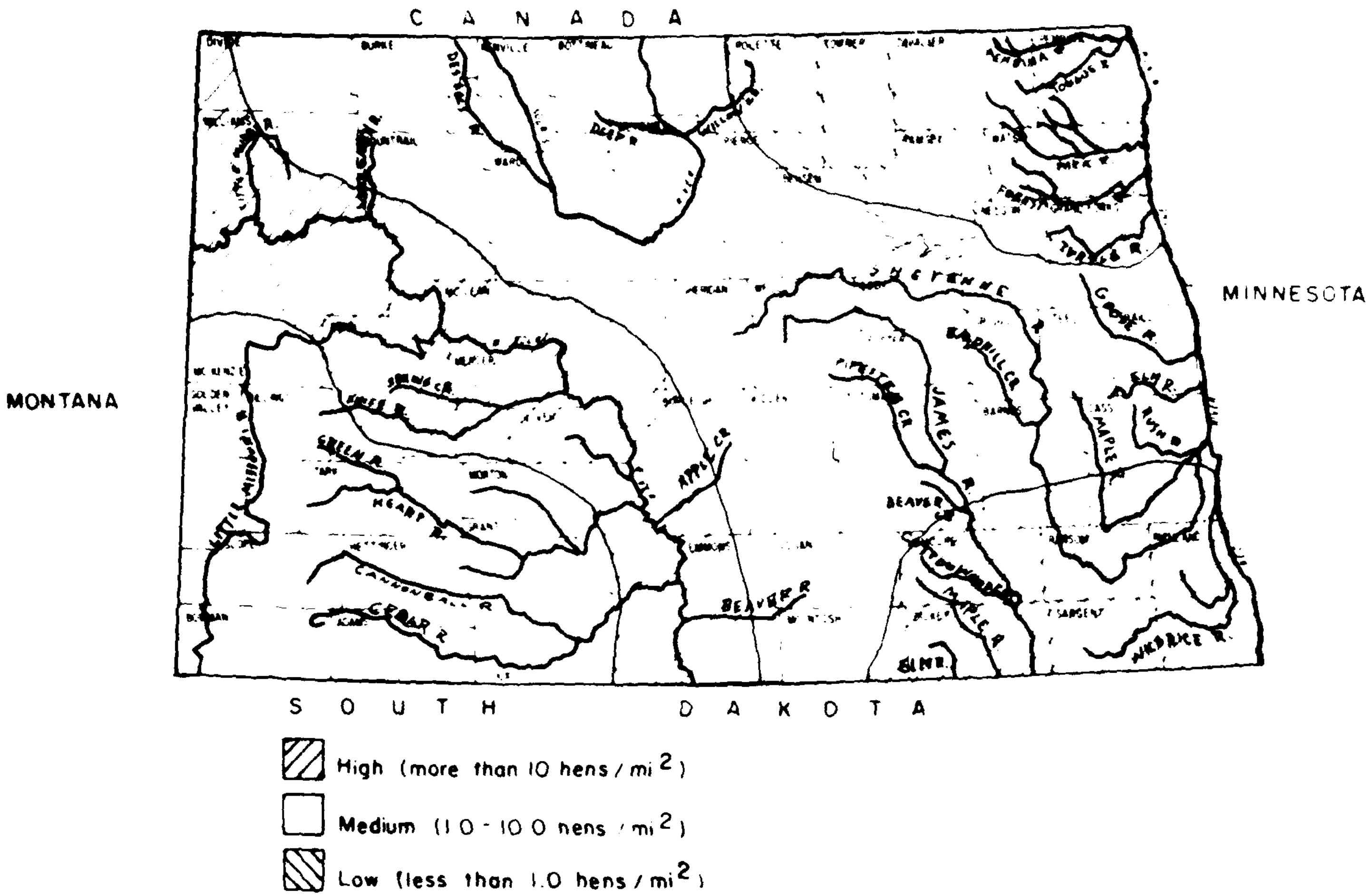
RED FOX DENSITIES — SPRING 1975

PLATE D-2



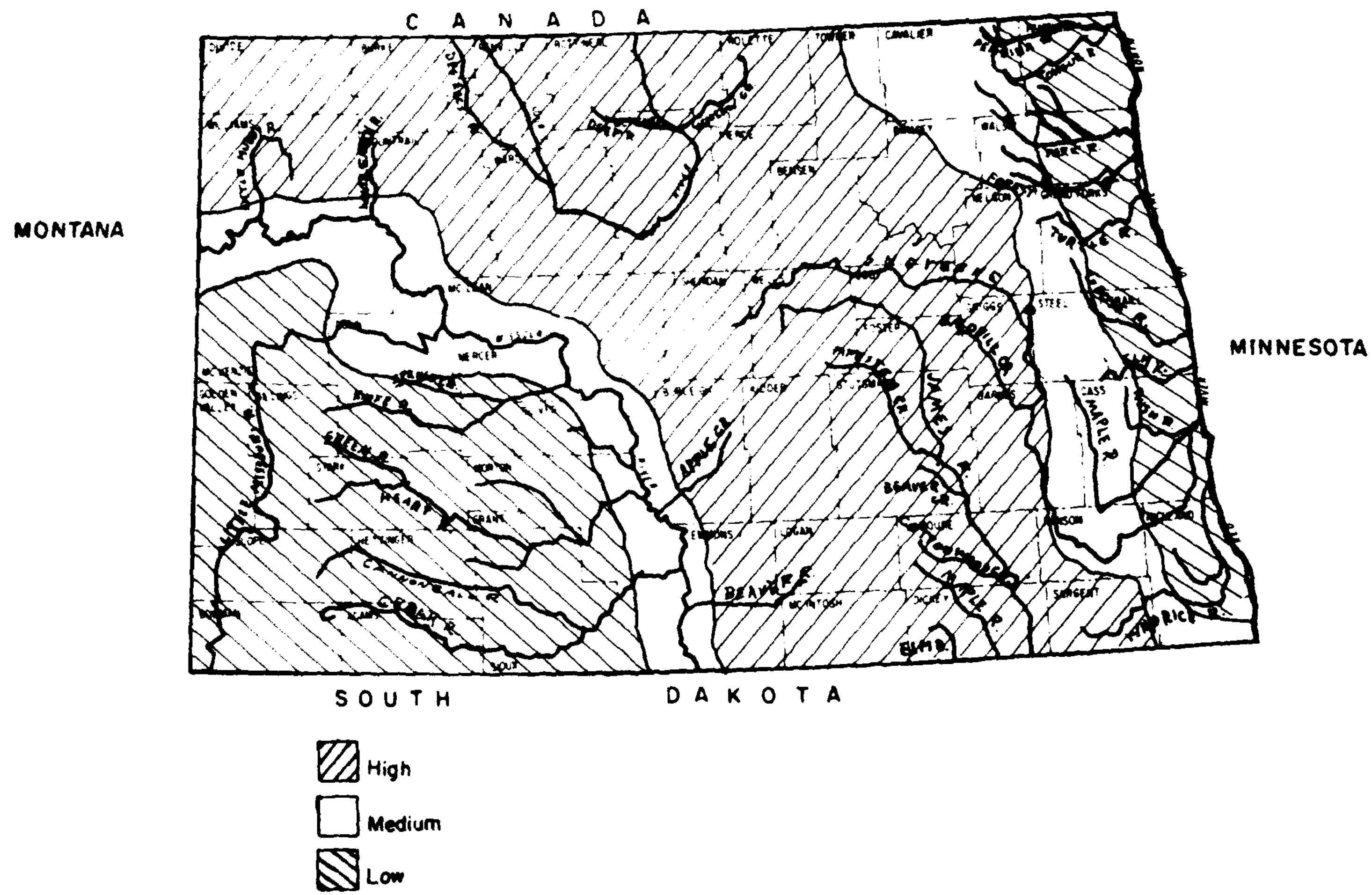
TREE SQUIRREL HABITAT

PLATE D-3



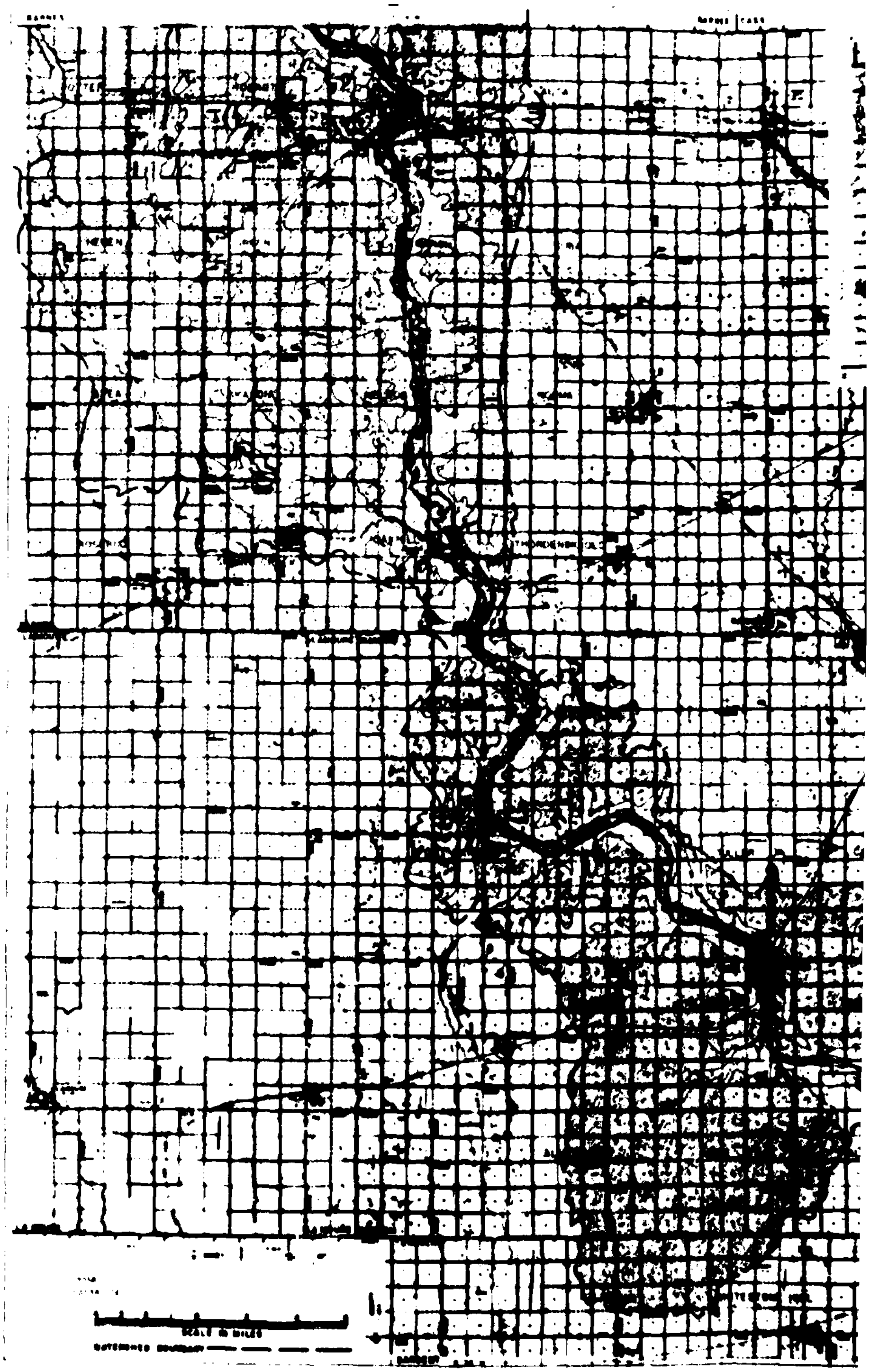
PHEASANT POPULATION DENSITY

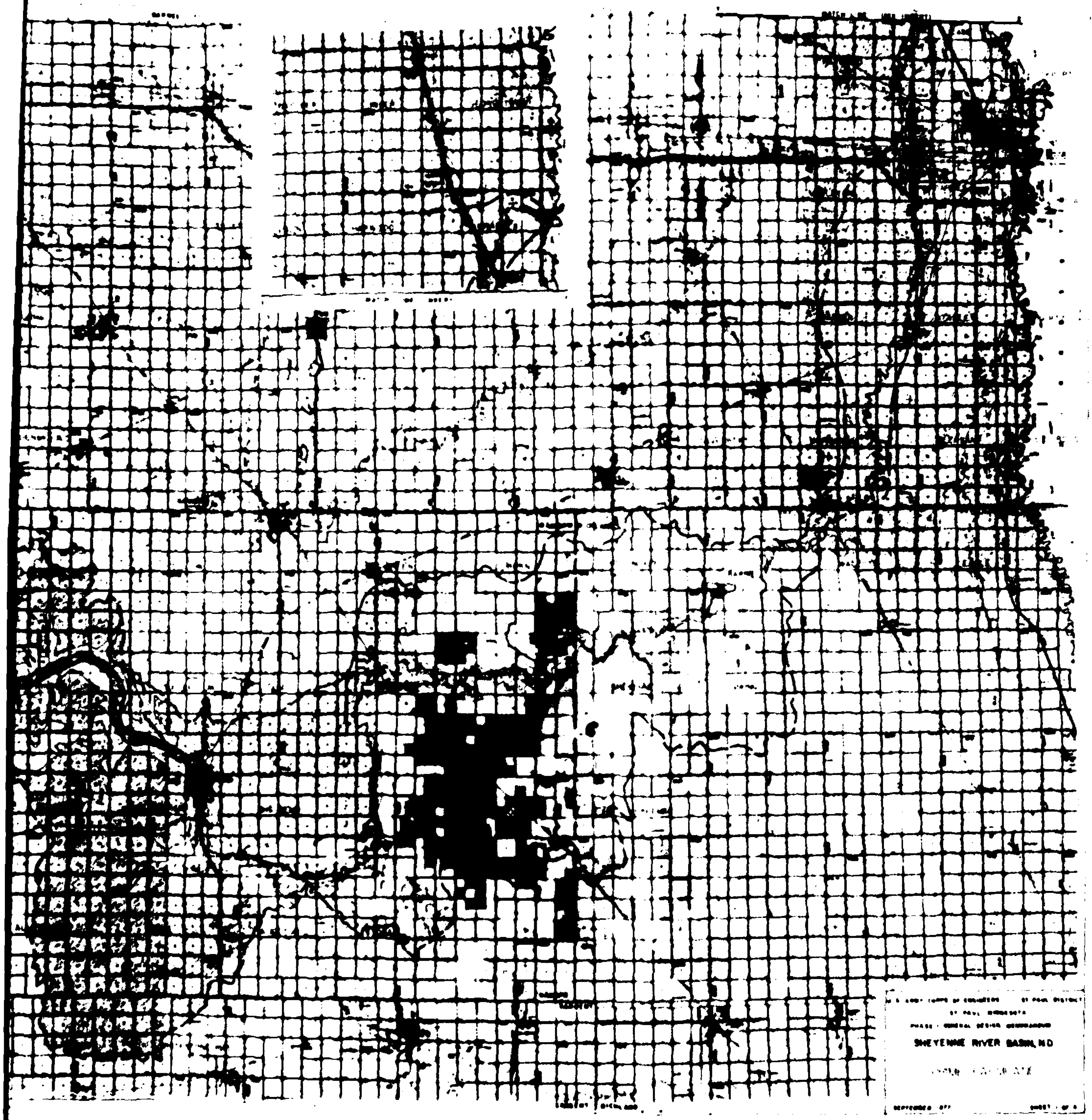
PLATE D-4



WATERFOWL POPULATION DENSITY

PLATE D-5





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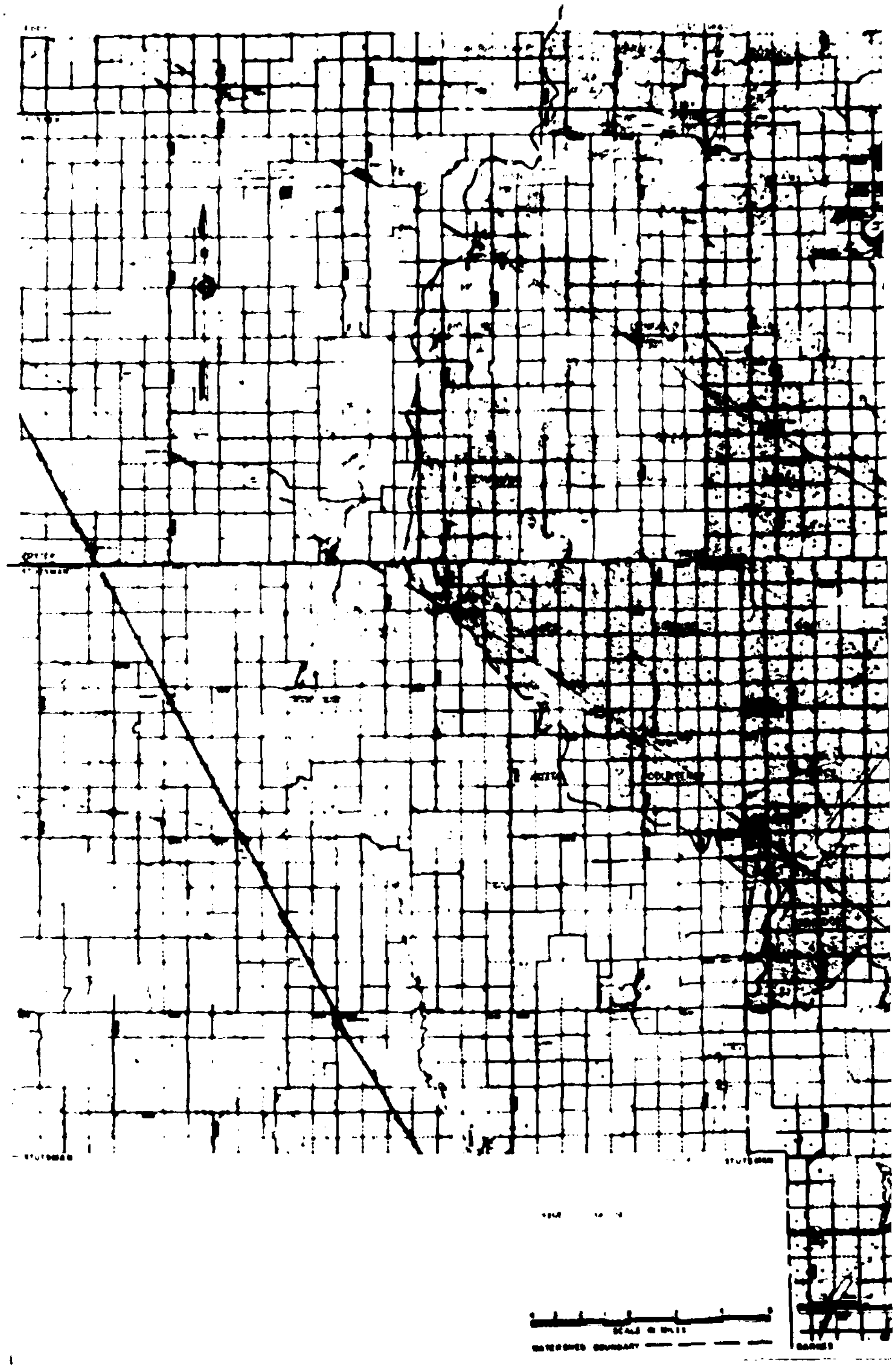

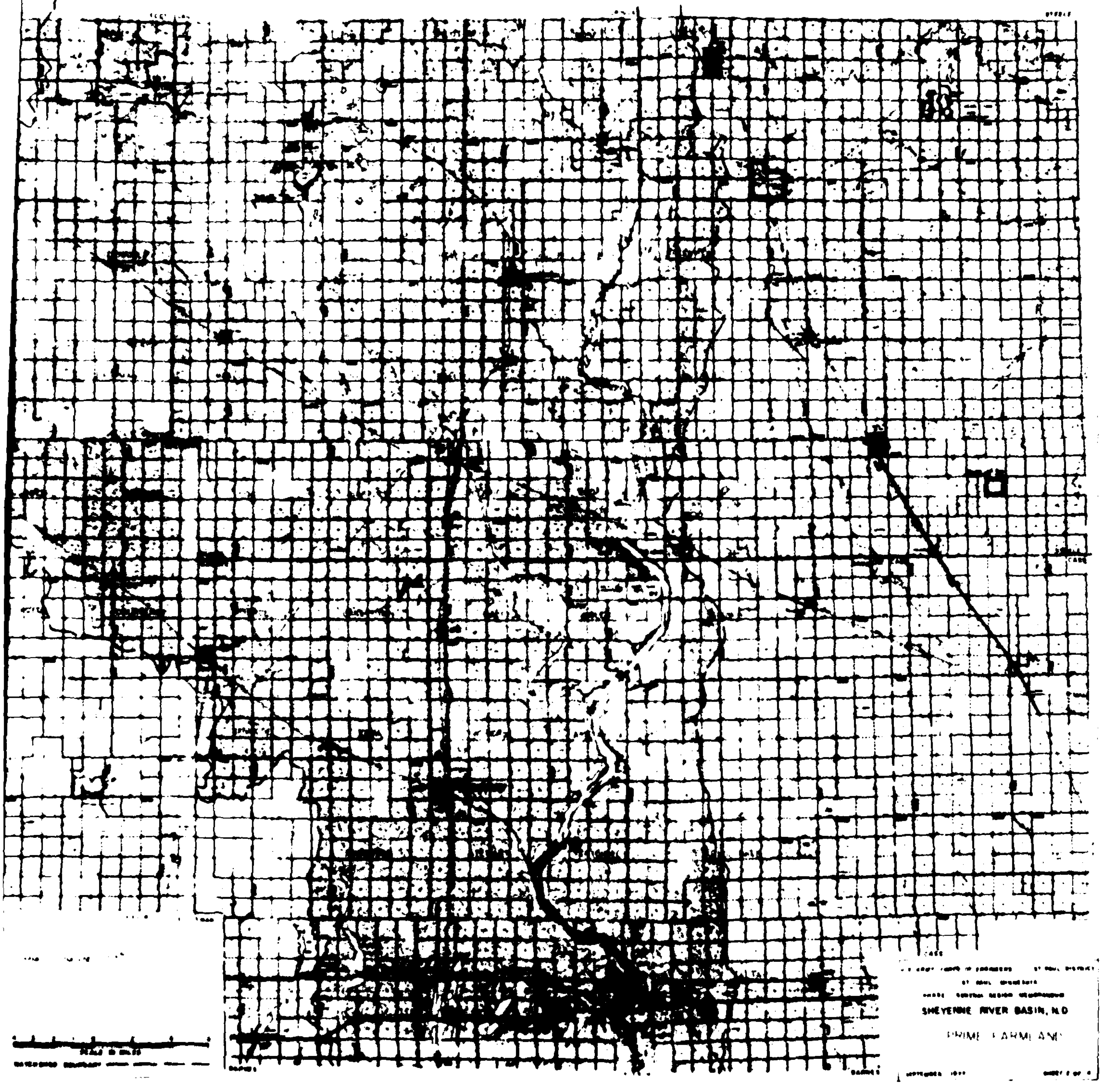

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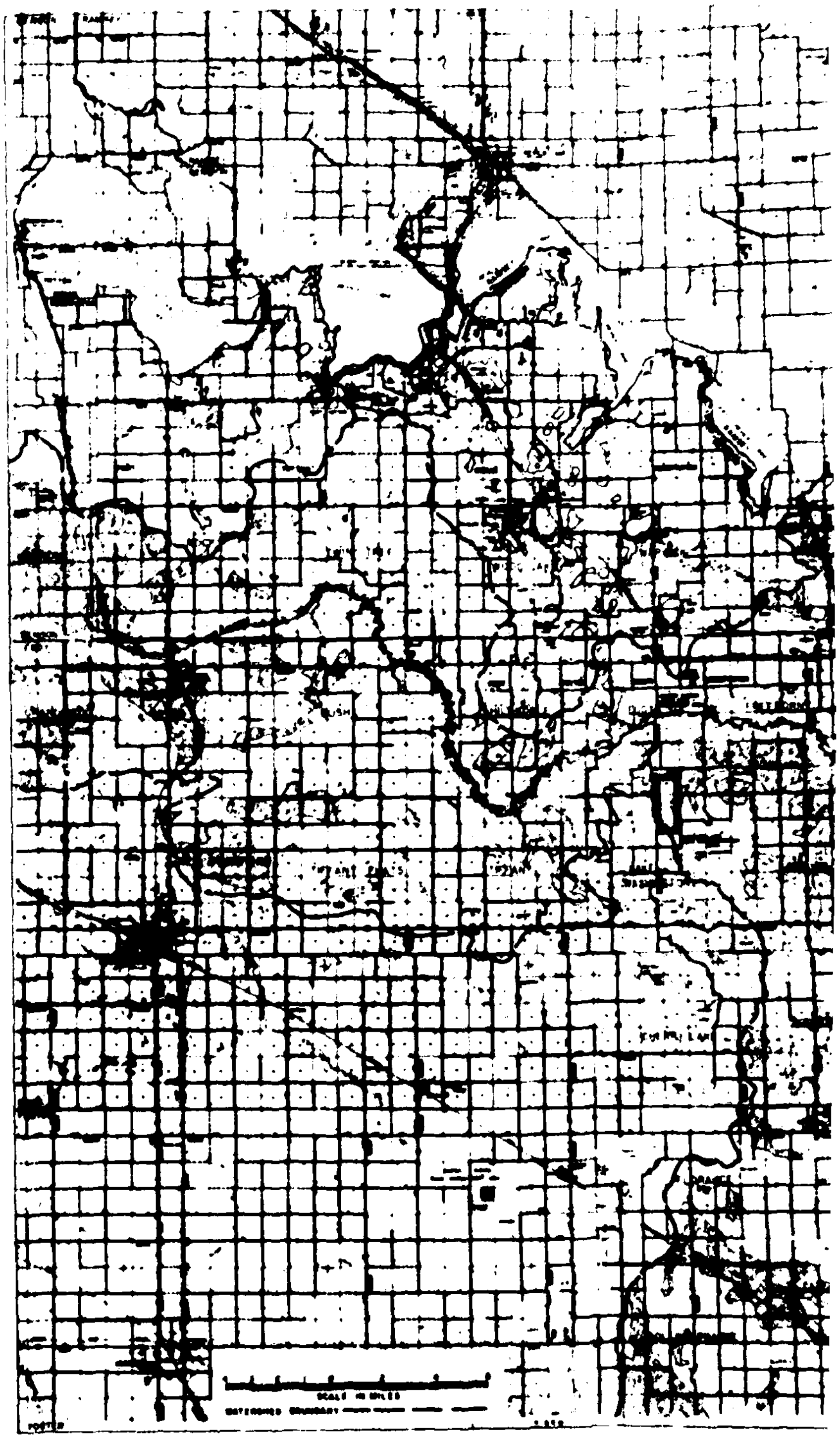

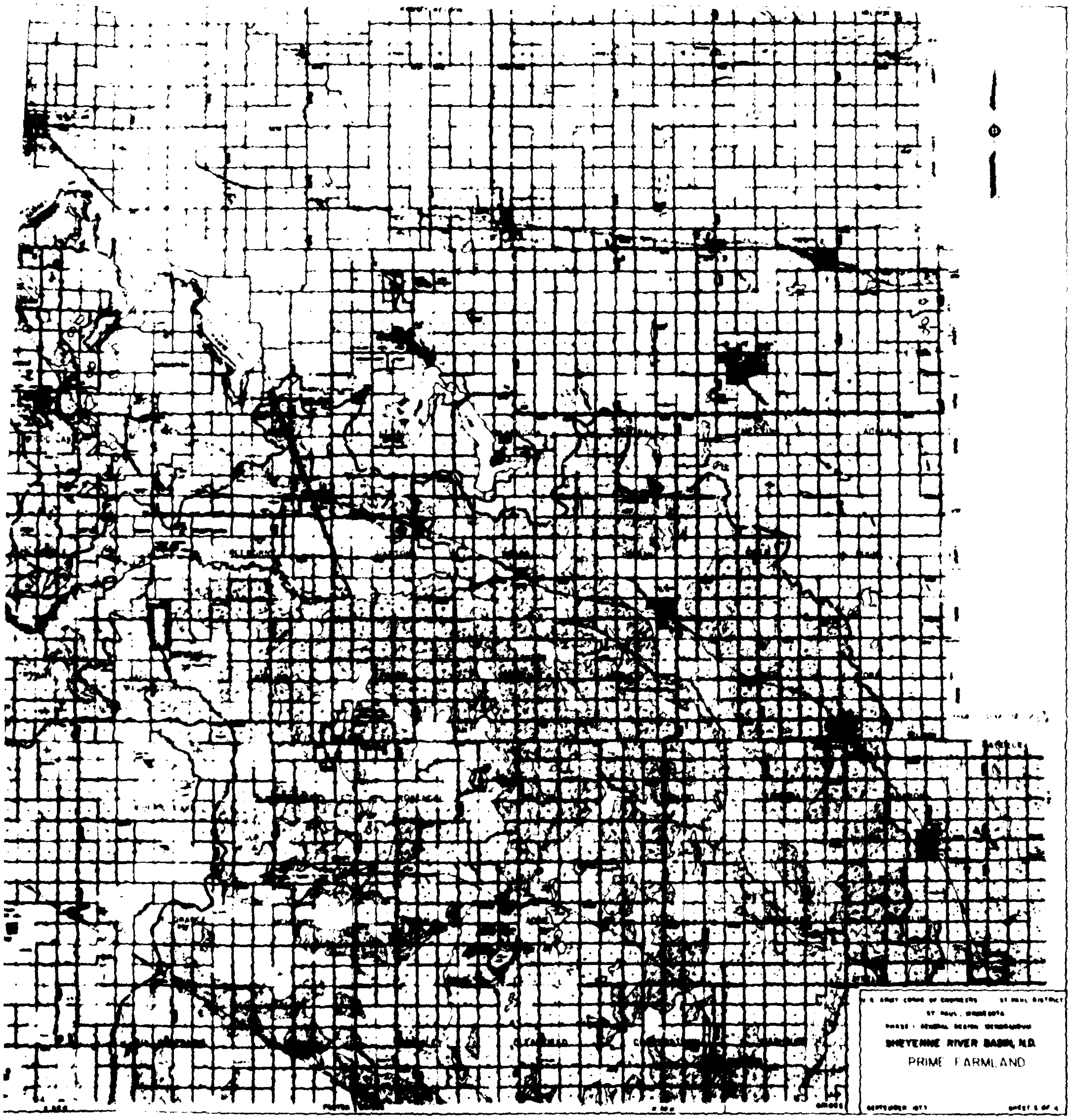

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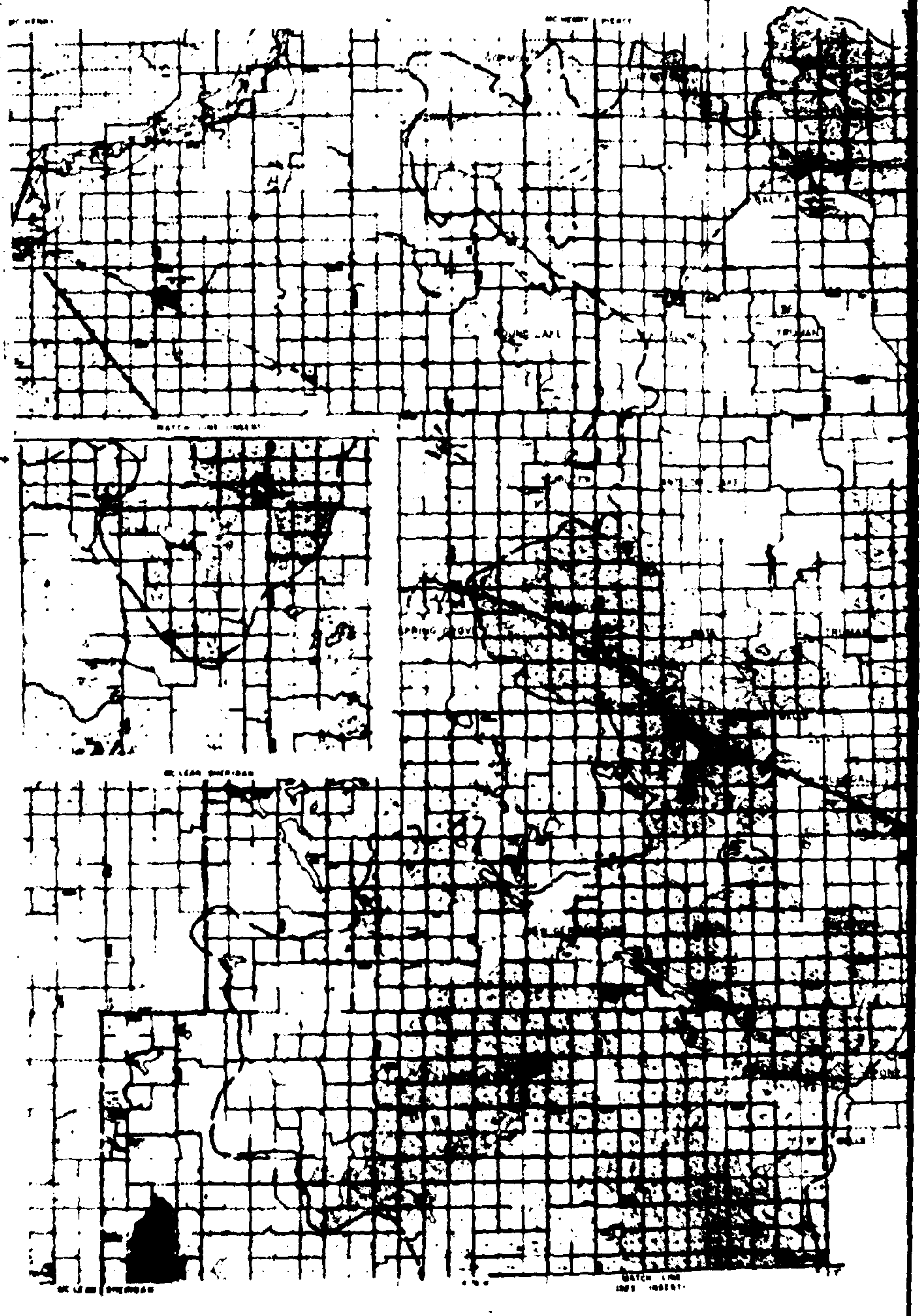

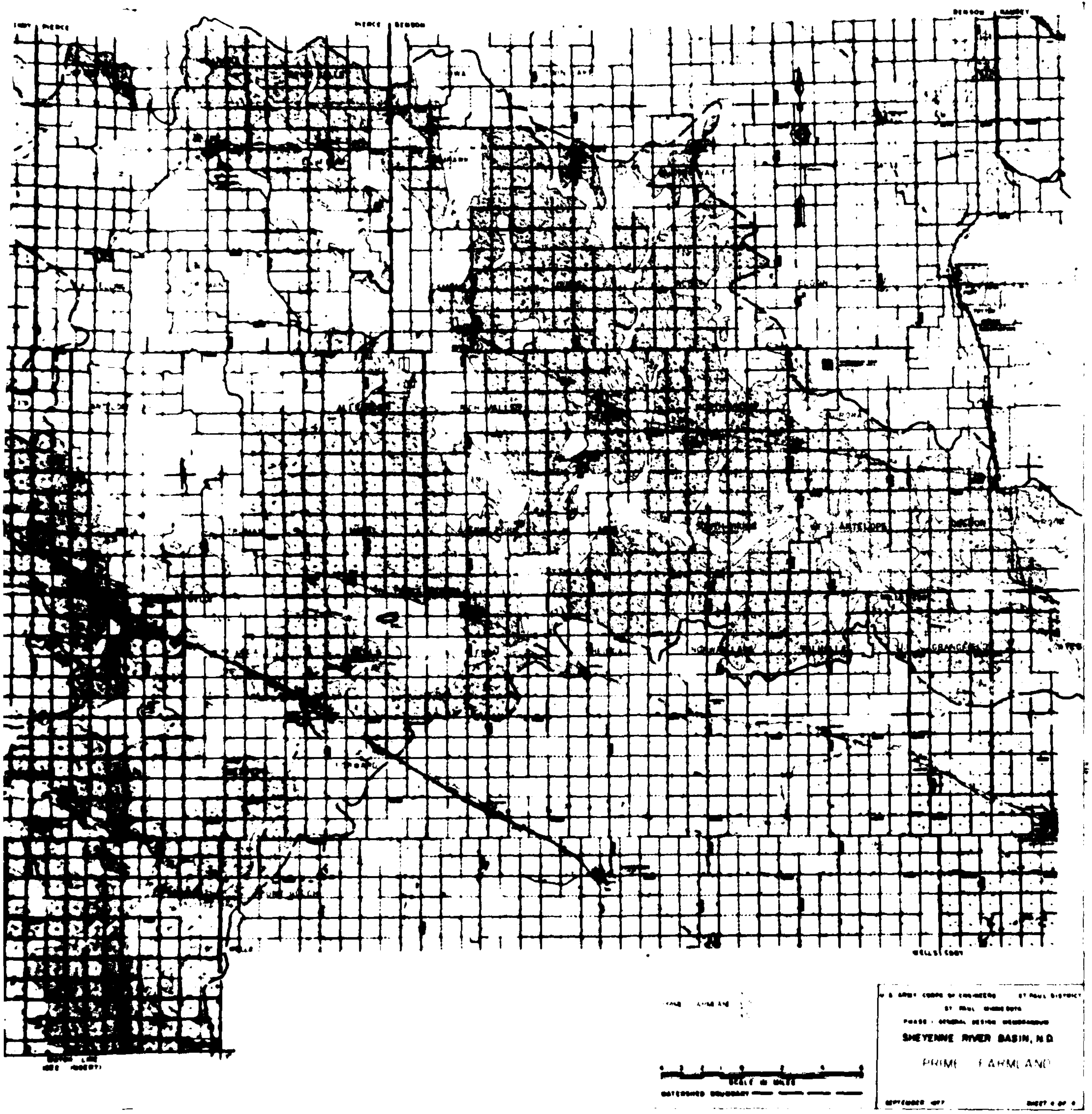

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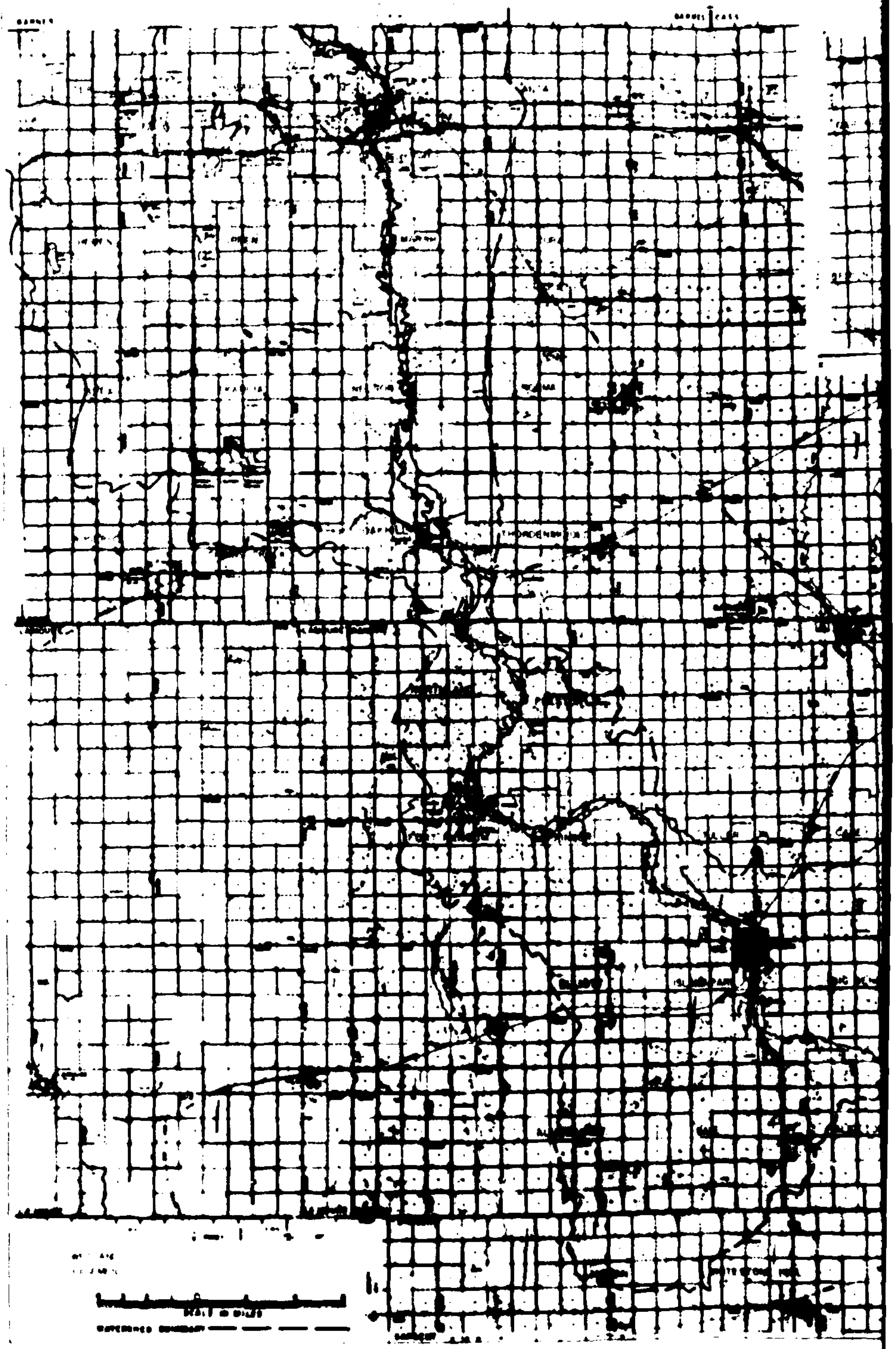

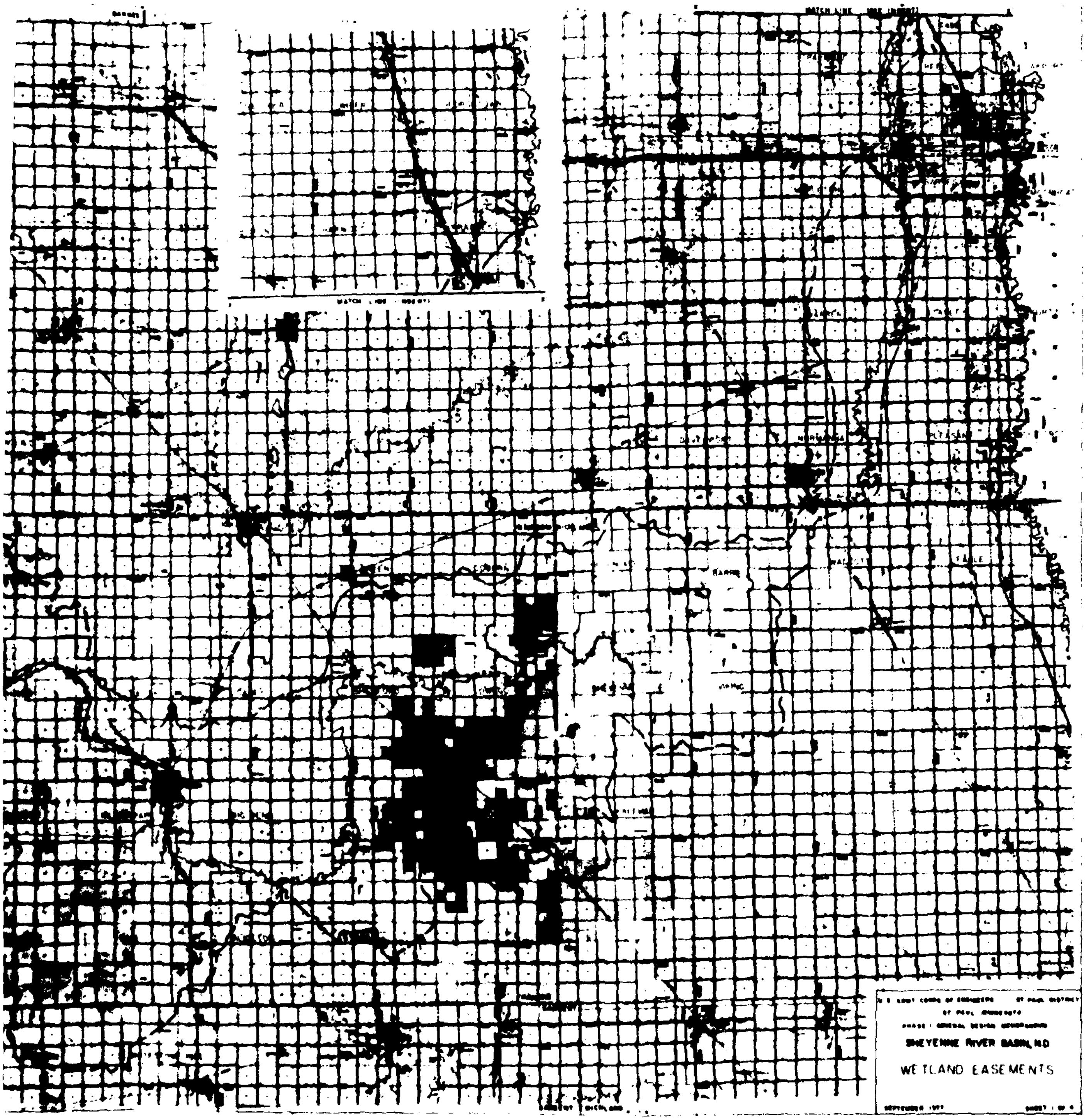

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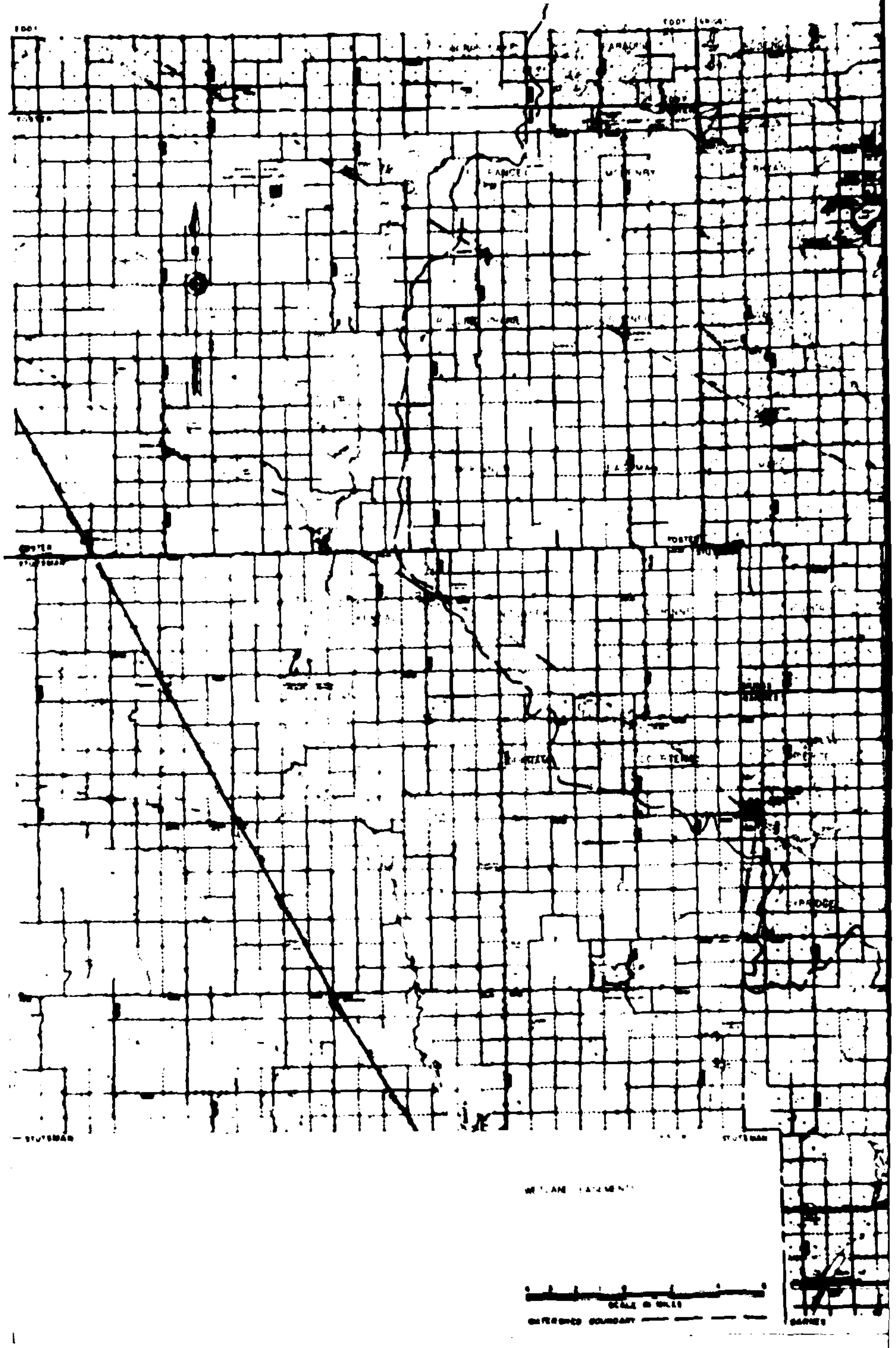

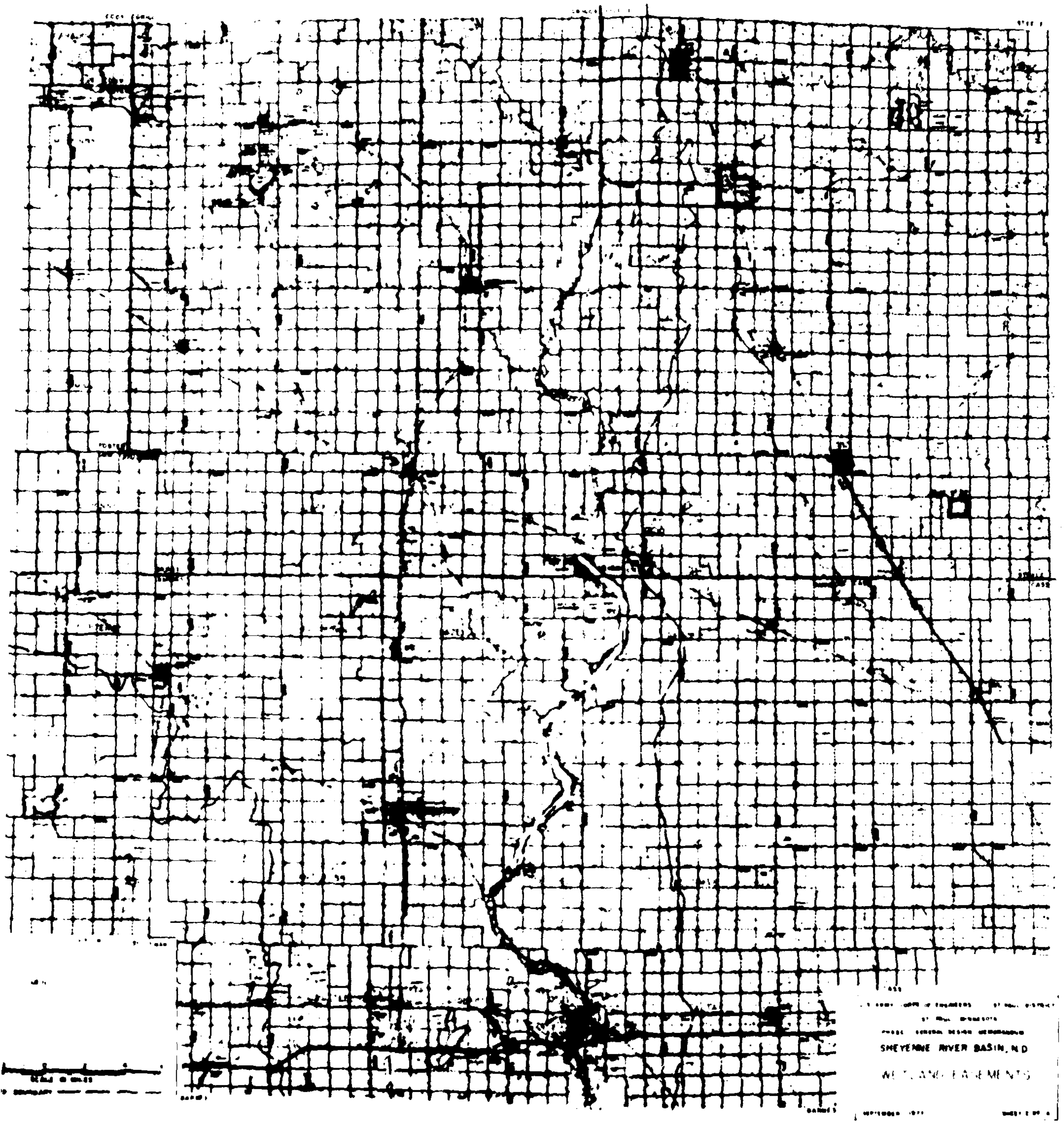

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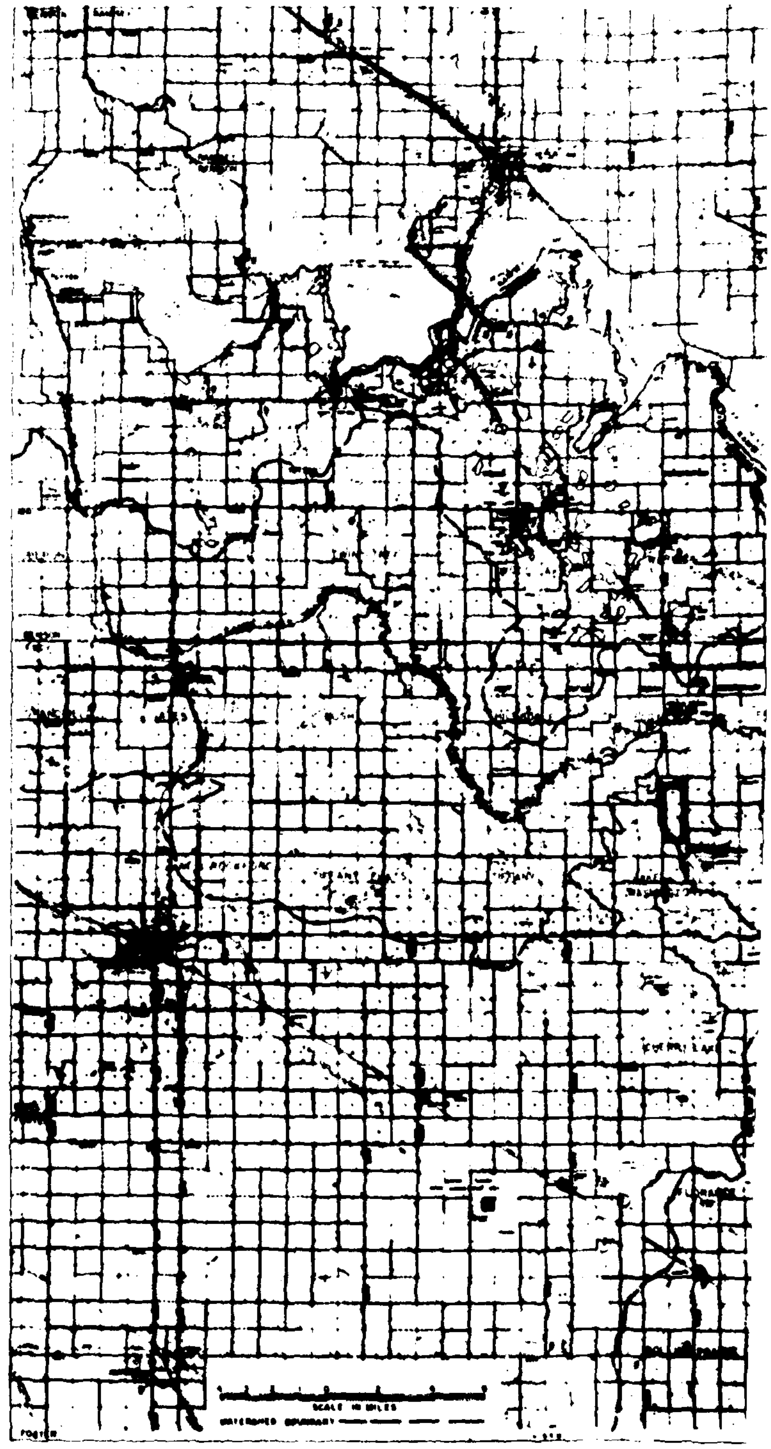

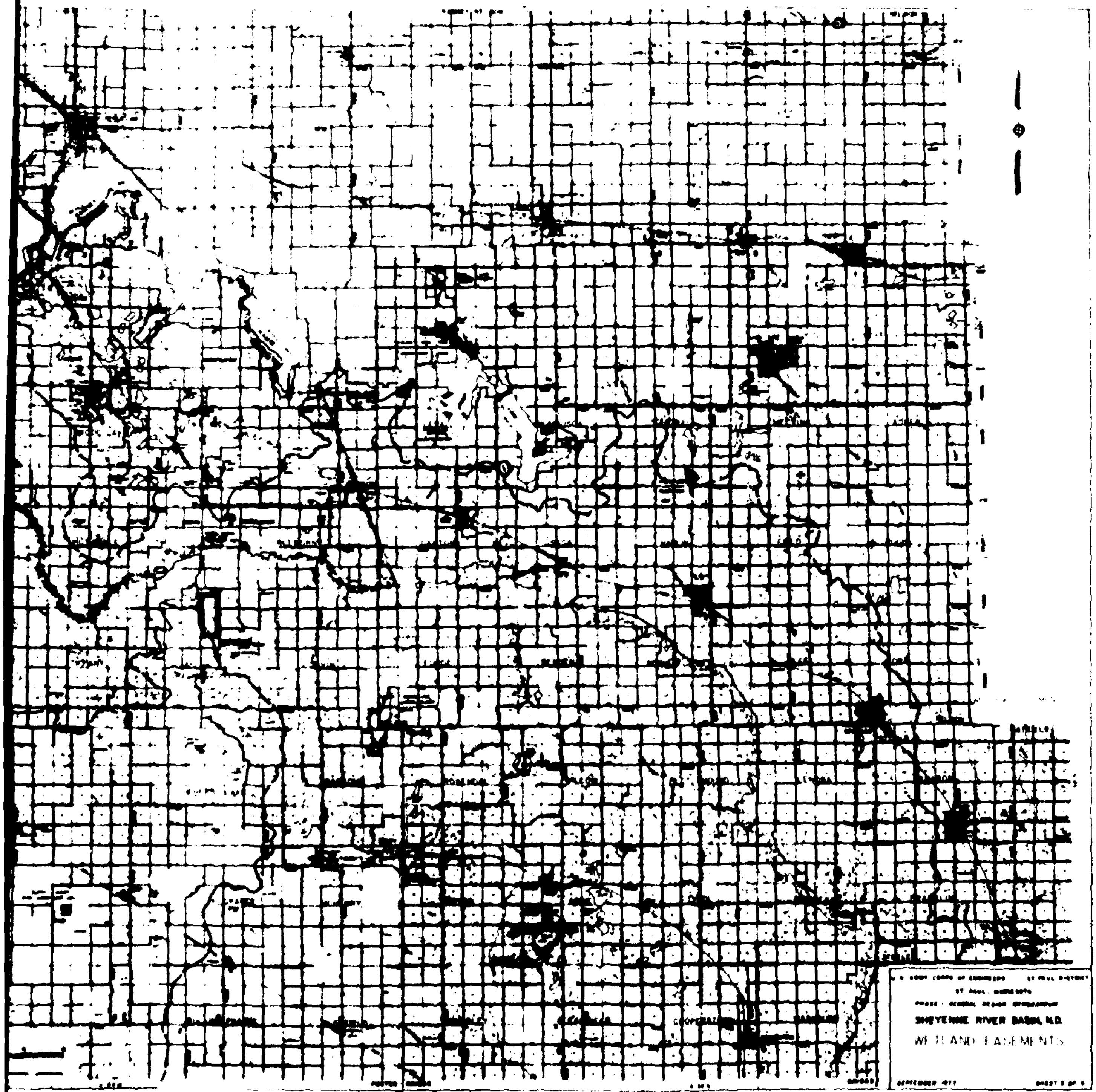

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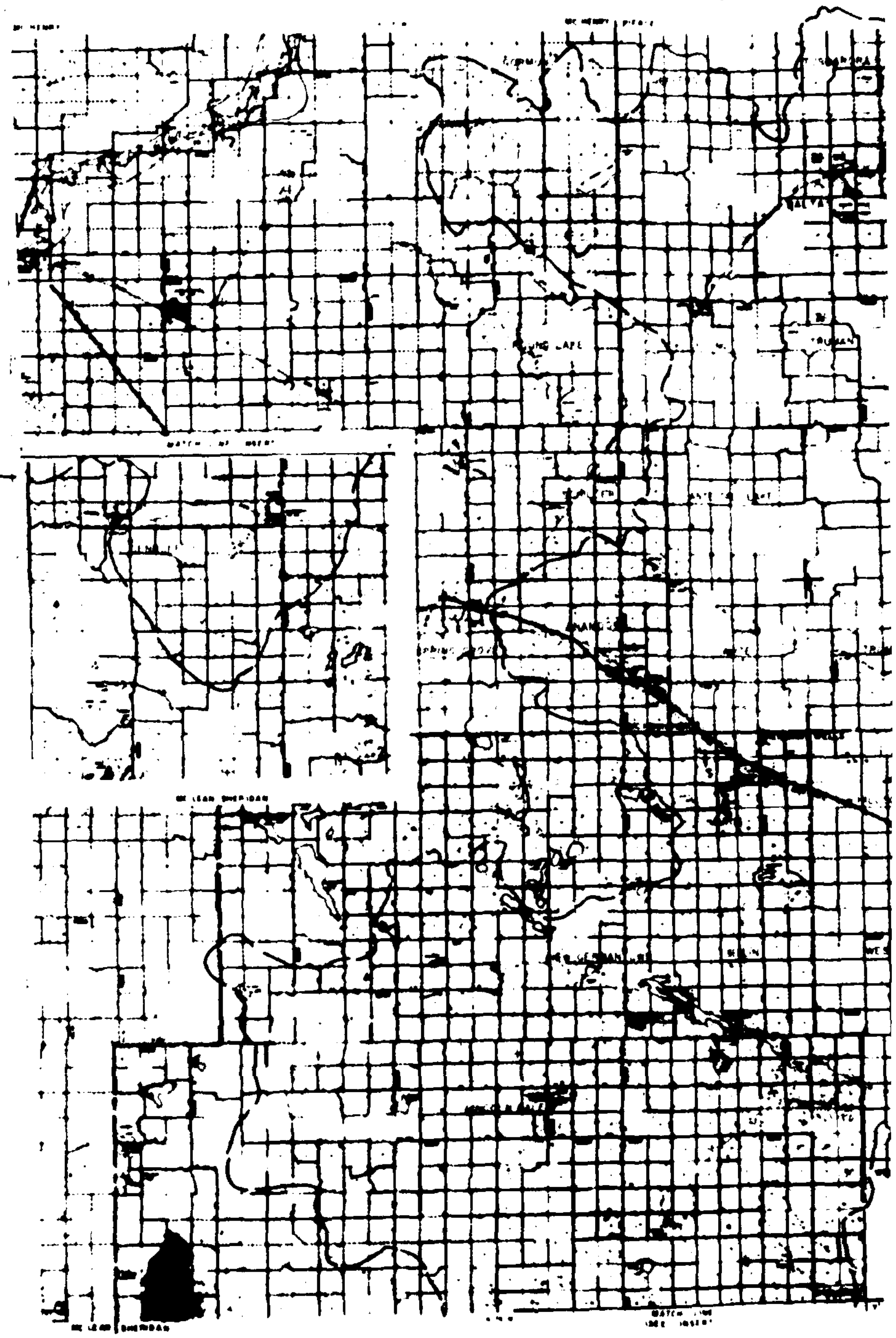

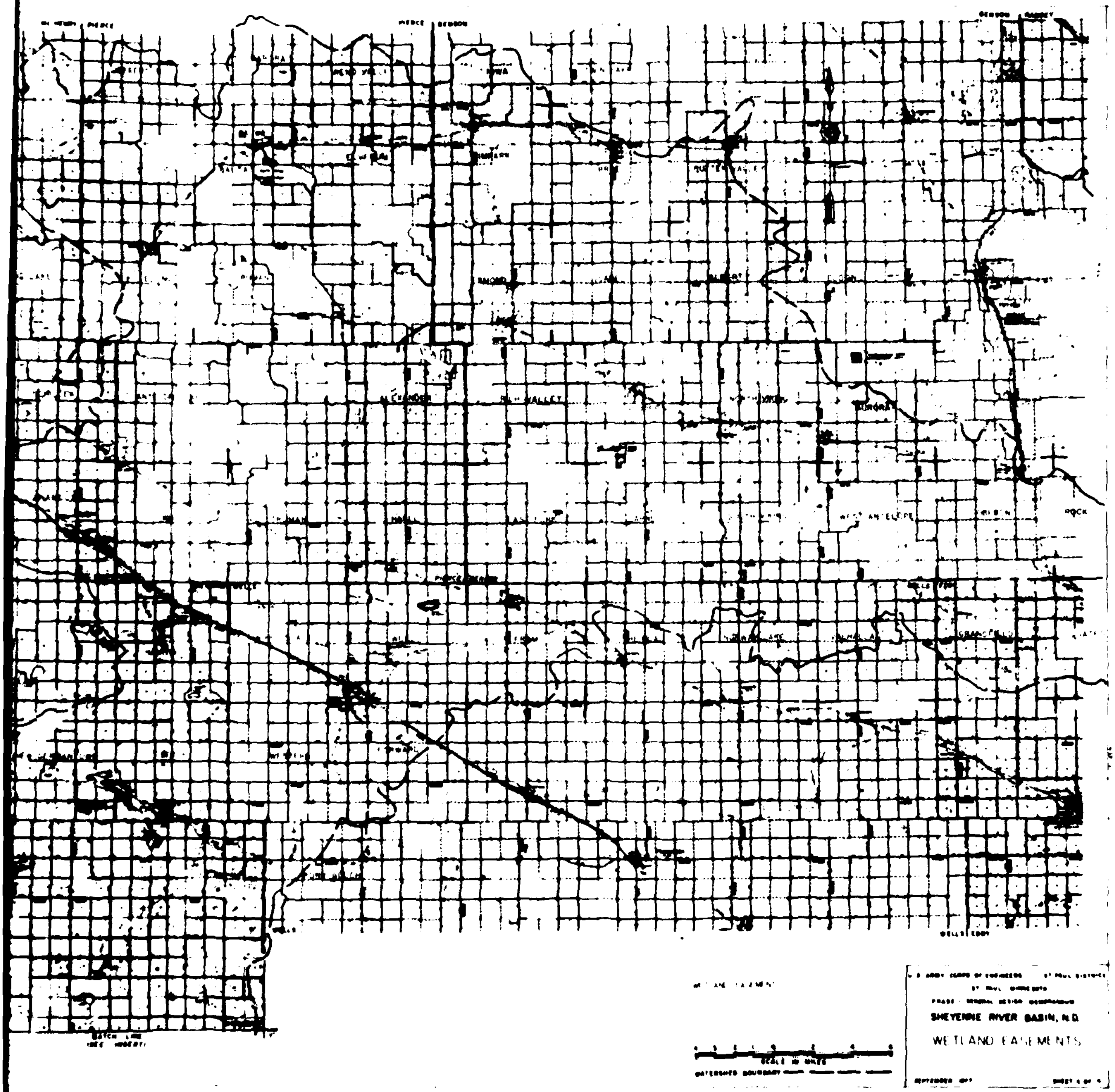

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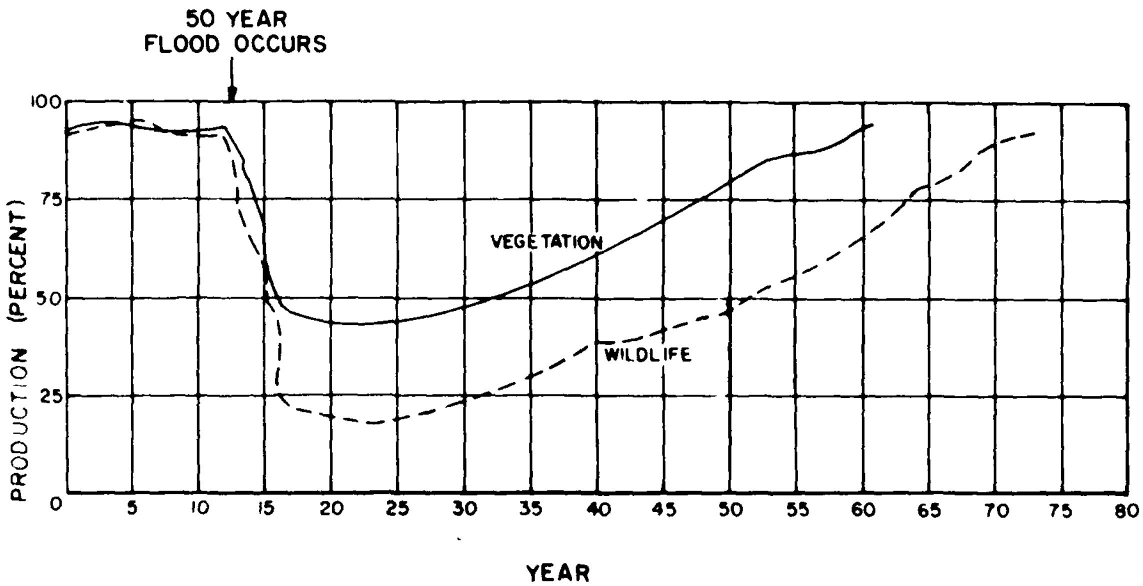
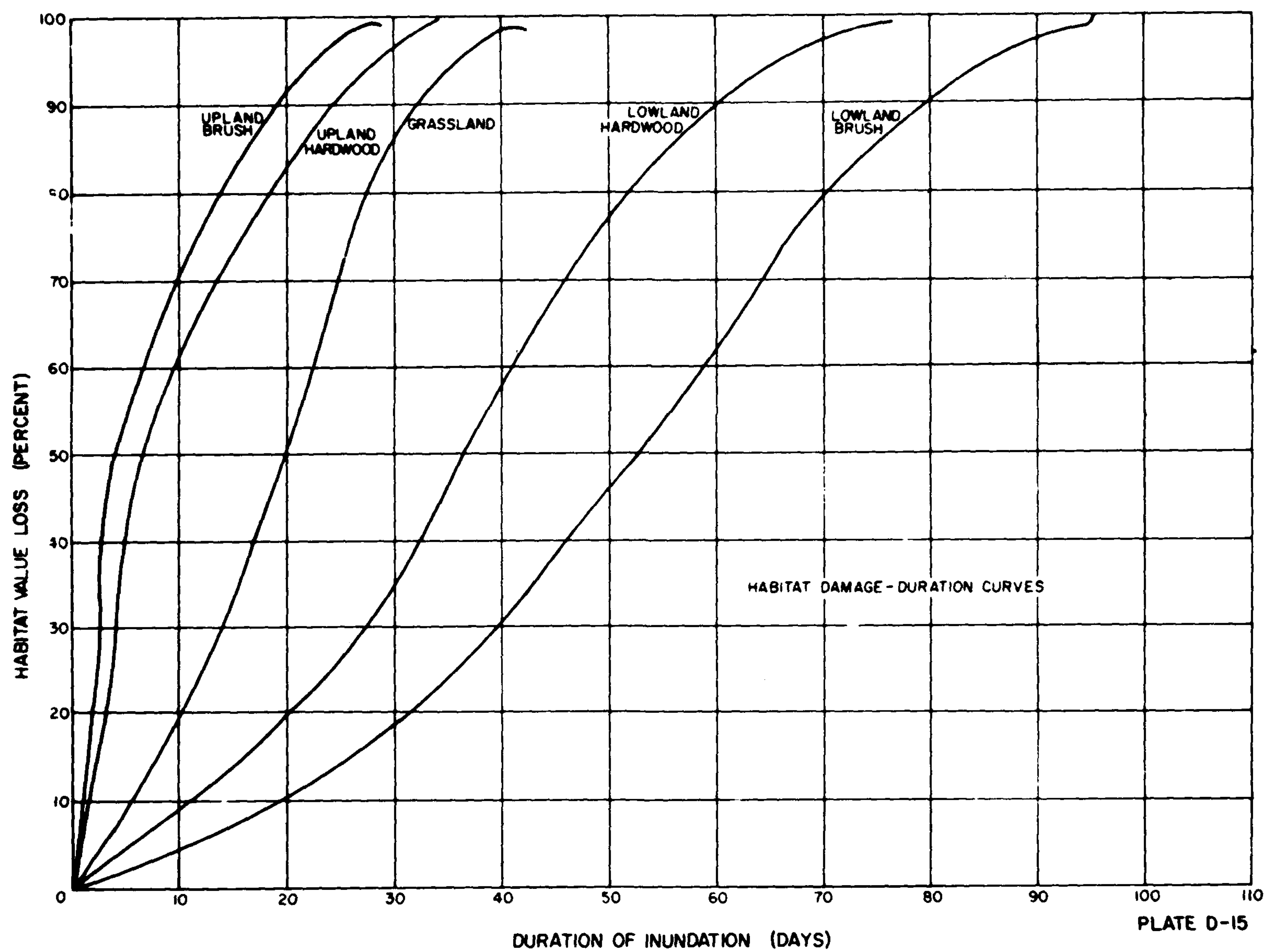
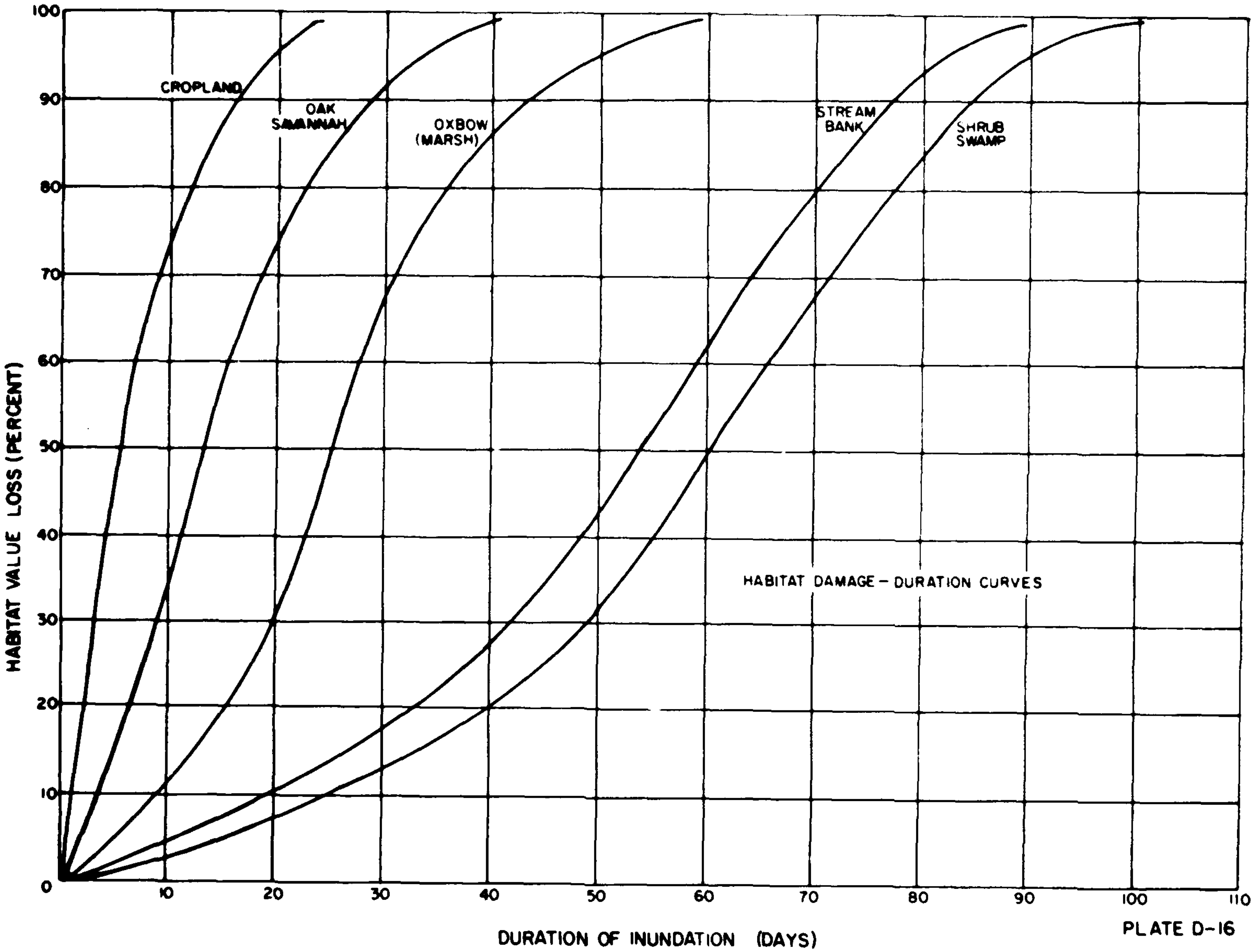


RELATIONSHIP BETWEEN
VEGETATION LOSS AND
WILDLIFE PRODUCTION.



HABITAT VALUE LOSS (PERCENT)
0
10
20
30
40
50
60
70
80
90
100
UPLAND BRUSH
UPLAND HARDWOOD
GRASSLAND
LOWLAND HARDWOOD
LOWLAND BRUSH
HABITAT DAMAGE - DURATION CURVES
10
20
30
40
50
60
70
80
90
100
110
DURATION OF INUNDATION (DAYS)

PLATE D-15



HABITAT VALUE LOSS (PERCENT)
0
10
20
30
40
50
60
70
80
90
100
DURATION OF INUNDATION (DAYS)
10
20
30
40
50
60
70
80
90
100
110
CROPLAND
OAK SAVANNAH
OXBOW (MARSH)
STREAM BANK
SHRUB SWAMP
HABITAT DAMAGE – DURATION CURVES

PLATE D-16

APPENDIX E

CULTURAL RESOURCES

GENERAL REEVALUATION

AND

ENVIRONMENTAL IMPACT STATEMENT

SHEYENNE RIVER, NORTH DAKOTA

AUGUST 1982

APPENDIX E

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PAST STUDIES

There have been a number of cultural resource investigations in the Sheyenne River basin since 1946, all of which were conducted for the Corps of Engineers. The first survey was conducted by the Missouri Valley Project, River Basin Surveys, of the Smithsonian Institution in 1946. It included the area from the proposed damsite in sec. 35, T. 150 N., R. 64 W., to 15 miles upstream. Spot checks were made an additional 12 miles upstream. This survey located 11 sites, including 4 ceramic scatters, 4 mound groups and 3 probable campsites.

Another survey was conducted by the River Basin Surveys in 1947 at the Baldhill Reservoir on the Sheyenne River in Barnes County. The area surveyed was from the damsite in sec. 18, T. 141 N., R. 58 W., to the Great Northern Railroad bridge, approximately 17 miles away. This survey located 10 sites, including 6 occupational areas, three mound groups, and 1 site of unknown type.

A literature search and records review of the Sheyenne River basin was conducted by Vehik and Vehik in 1977, under contract with the St. Paul District. The results of their investigation are detailed in a report entitled A Literature Review of Archaeological, Historical, and Paleontological Resources of the Sheyenne River Basin in North Dakota. This investigation entailed a comprehensive review of previous studies in order to identify known archaeological and historic resources in the basin, as well as potential site leads. For ease of data retrieval, the literature search and records review delineated three areas, the Upper, Middle, and Lower Sheyenne basin. The investigation also included

the Maple River basin.

Although there were a number of recorded sites in the survey area, they were primarily located in the Upper Sheyenne basin, site of the Bureau of Reclamation's proposed Lone Tree Reservoir. In the lower and middle portions of the basin there had been only brief archaeological surveys, varying in scope and intensity. Historic site surveys have never been conducted within the Upper, Middle and Lower Sheyenne basins, which accounts for the lack of known historic sites.

In order to make a general identification of the number, types, and quantities of cultural resources in the area and in order to verify site leads in the Lower Sheyenne basin below Baldhill Dam, a cultural resources reconnaissance level survey was conducted in 1977 by Vehik and Vehik under contract with the St. Paul District. The results of this survey were detailed in a report entitled An Archaeological Survey of Selected Portions of the Lower and Middle Sheyenne River Basin in North Dakota. The fieldwork was based on the literature search and records review conducted by Vehik and Vehik (1977) and consisted of informant interviews and pedestrian reconnaissance in selected areas of the lower Sheyenne River valley.

The survey located 61 sites, 5 historic and 56 prehistoric. All of these sites were previously unrecorded, although 11 were originally site leads.

The general areas included in the fieldwork were:

(1) North of West Fargo along the Sheyenne River to the confluence

of the Sheyenne and Red Rivers (channelization).

(2) South of West Fargo, extending slightly southwest of Horace (diversion).

(3) Southeast of Kindred, extending along both sides of Highway 46 (levee).

(4) The area of the proposed Kindred Reservoir in Ransom and Richland Counties (reservoir).

(5) A small section of land southeast of Lisbon along Dead Colt Creek (dam).

(6) A circular area southwest of Lisbon along Timber Coulee (dam).

(7) Upstream of existing Lake Ashtabula as far north as Cooperstown (pool raise).

All of these areas are in Cass, Griggs, and Ransom Counties in eastern North Dakota.

An aerial infrared photographic survey at Lake Ashtabula was also conducted in 1977 by Strachan and Roetzel of Mankato State University, under contract with the St. Paul District. The purpose of this survey was to locate archaeological sites that contained no surface manifestations by outlining high, medium, and low potential site areas based on the infrared photographs.

The last survey conducted in the Sheyenne River basin was completed in 1980 by Richard Fox, under contract with the St. Paul District. The survey was completed under E.O. 11593 and was not specifically part of the Sheyenne River basin project. This investigation included a litera-

ture search, intensive pedestrian survey, and a nonsystematic testing program. The results were detailed in a report entitled 1978-1979 Cultural Resource Investigations Along the Middle Sheyenne River Valley Including Lake Ashtabula and a Portion of the Sheyenne River. A total of 41 previously unrecorded sites were located and 5 sites located by Vehik (1977) were resurveyed, from which 37 prehistoric sites, 6 historic sites and 1 paleontological site were identified.

The survey area included lands adjacent to the free-flowing portion of the Sheyenne River north from Lake Asthabula to U.S. Highway 200. The general areas included in the fieldwork were:

(1) Corps-owned land.

(2) All lands adjacent to Lake Ashtabula to elevation 390.14 meters msl.

(3) Baldhill Creek within sections 1 and 12, T. 142 N., R. 58 W.

(4) Upstream of Lake Ashtabula north to the Wells Bridge Crossing to elevation 390.14 meters msl.

All of these areas are in Griggs, Steele, and Barnes Counties.

SUMMARY OF THE PREHISTORIC PERIOD IN THE SHEYENNE RIVER BASIN

Summarizing archaeological developments in the Sheyenne River basin is difficult due to the lack of adequately excavated material. Therefore, the following summary will draw on information from outside the immediate research area.

Paleo-Indian

The earliest cultural group represented in the research area is the Folsom Culture, dated between 10,000 and 8000 B.P. (Johnson 1962: p. 161). The Folsom People were hunters, primarily of bison which are now extinct (Vehik and Vehik 1977: p. 64). Sites of this culture, represented by isolated finds of Folsom-like projectile points, seem to be more common further north and west along the upper Sheyenne River and James River. However, Folsom points have been located in the upper parts of the Sheyenne delta (Johnson 1962: p. 162). This suggests that the Folsom Culture was probably present while the diminishing Lake Agassiz II was in existence (Johnson 1962: p. 162). Also, a Paleo-Indian site dated from 10,025 to 9525 B.P. was excavated along the beaches of glacial Lake Agassiz in Manitoba (Saylor, 1975).

The Plano Culture followed and was partially contemporaneous with the Folsom Culture in parts of the northern Plains. However, no Plano-like artifacts have been recovered in the Sheyenne River basin, and they are not abundant in other areas of eastern North Dakota. One isolated find of a Yuma-like point is reported from Stutsman County (Kammerer 1942: p. 123).

Archaic

This period is characterized in the eastern United States by the presence of ground, polished, and chipped stone and by local adaptations to specific environments (Johnson 1962: p. 162). Chronologically, it

begins about 8000 B.P. and may have lasted until about 2000 B.P.

Unfortunately, well-defined, known Plains Archaic sites are absent in the research area and in most of the northern Plains. This is a result of a lack of investigations of earlier terrace systems and sediments in particular and the probability that many Archaic sites may be deeply buried (Reeves 1973: p. 1243). However, a few Archaic sites have been found in areas adjacent to the Sheyenne River basin. One of the earliest is the Minnesota Man site, 21OT3, in Minnesota. This is a burial site located in the bed of glacial Lake Pelican and is believed to date around 6000 B.P. (Johnson 1969; Streiff 1972: viii, 17). Also, the Cemetery Point site and Component "A" of the Grand Rapids site in Manitoba are associated with the Whiteshell Archaic Phase, which dates from about 5000 to 3500 B.P. (Mayer-Oakes 1967: p. 375).

Another possible Archaic site in proximity to the Sheyenne River basin is 32LM201 in LaMoure County (Mallory 1966: p. 29-30 and Vehik n.d.: p. 73). This site, which may be 7 feet deep, consists of three stratigraphic layers (Mallory 1966: p. 30). In addition, isolated finds of material belonging to the Old Copper Culture have been located near the towns of Lakota and McHenry, North Dakota (Spiss 1968: p. 125).

Woodland

The Woodland period (2000-800 B.P.), characterized by the addition of pottery and the use of burial mounds, appears to follow the Archaic period. Cultures from this period appear around the beginning of the

Christian era, but for the most part, their occupation of the northern Plains is poorly defined.

There is little evidence of Early Woodland occupation in the northern Plains (Syms 1977: p. 129). One possible site is Morrison Mound 13 in western Minnesota, with a radiocarbon date of 2640 B.P. (Wilford et al. 1969: pp. 24-25, 50). Data become much more frequent in the northern Plains with Middle Woodland occupations. The groups occupying central and eastern North Dakota and adjacent regions were of two general types, Sonota and Laurel. The following description of Woodland and Mississippian Plains Village Tradition is derived almost entirely from Vehik and Vehik (1977: pp.68-75).

The Sonota Complex, as defined by Neuman, is one component of a cultural tradition occupying most of the northern Plains and consists of a series of campsites and mounds found in the Dakotas from the Missouri River trench eastward to western Minnesota. The major difference between the Sonota Complex and groups to the west, such as the Besant Culture, is the former's mound building activities (Neuman 1975: p. 96). Otherwise, sites belonging to this tradition share an emphasis on communal bison hunting and show a number of similarities in their chipped and ground stone artifacts. Their similarities in pottery, however, are less pronounced (Neuman 1975: p. 81). Much of the mortuary complex and some of the ceramic attributes of the Sonota Complex are thought to reflect Hopewellian influences (Neuman 1975: pp. 83-84, 96).

Traits similar to those of the Sonota Complex have also been recognized in some of the mounds assigned to the Malmo Focus of southern Minnesota. These include log-covered secondary burials (but not central burial chambers), certain pottery attributes, and the inclusion of bison skeletons and/or skulls as burial accompaniments (Neuman 1975: p. 87).

There are few sites within the research area which may belong to the Sonota Complex. The Baldhill Mounds, 32BA1, has been included in the complex by Neuman (1975: p. 79). Also Strong's (1940: p. 385) Lisbon Mound may belong to the Sonota Complex or one of the southern Minnesota groups.

The Laurel Culture extends from the eastern margin of the northern Plains around the north shore of Lake Superior and into the Upper Peninsula of Michigan. It too was characterized by a hunting and gathering way of life, possibly organized into a seasonal pattern, centering on the exploitation of fish, moose, and beaver (Stoltman 1973: p. 3).

The strongest relationships of Middle Woodland Laurel Culture appear to be to the east, with other Great Lakes cultures such as Point Peninsula. Evidence of Hopewellian influence includes the occasional appearance of obsidian, certain ceramic attributes, and the practice of mound burial (Stoltman 1973: p. 3). Unlike the Sonota Complex mounds, Laurel mounds lacked a central burial chamber and were accretional. Certain burial practices, such as breaking long bone ends on secondary human interments, were found at the Grover Hand site of the Sonota Complex and Smith

Mound 4 of the Laurel Culture (Neuman 1975: p. 48, 87, and Stoltman 1973: pp. 9-11).

According to Stoltman (1973: p. 3), there is no evidence of Laurel Culture remains in any areas south of northern Minnesota. Within the Red River Valley drainage, Laurel materials occur at least as far south as the Snake River (Johnson 1973: p. 30). Nelson (1973: p. 76), in referring to archaeological work conducted by the University of Minnesota in southeast Sargent County, North Dakota, mentioned the occurrence of Laurel pottery.

Beginning around 1400 B.P., the Late Woodland Arvilla Complex appeared in the northeastern Plains and their periphery. It has been suggested that Arvilla was basically a mortuary complex associated with a series of foci or phases (Johnson 1973: p. 65). Since no habitation sites have been associated with this complex, little can be said regarding settlement and subsistence patterns. Basically, burials tended to be placed under both round and linear mounds with a burial assemblage reflecting northern origins and the addition of some marine shell trade goods from the south (Johnson 1973: p. 66).

The Arvilla Complex per se does not seem to appear in North Dakota west of the Red River Valley, with the exception of the Fordville area. However, the Complex does share some traits with the Sonota Complex, including the possession of prairie side-notched projectile points (Johnson 1973: p. 65).

Within the Red River Valley and northern Minnesota, the Blackduck Culture may have developed from an Arvilla Complex base. In central Minnesota, however, the Kathio Focus, which developed from the Malmo Focus, replaced Arvilla (Johnson 1973: p. 66).

The presence of the Blackduck Culture in the southern Red River Valley is not adequately documented. Nelson (1973: p. 76) noted that material from this culture was recovered from southeastern Sargent County by the University of Minnesota expedition, but little other data are available. However, in southern Canada, the Blackduck Culture may have continued to historic times and has been suggested to be prehistoric Assiniboine (Hlady 1970a: pp.108-110).

The Kathio Focus dates from at least 1400 to 1000 B.P. (Wilford 1970: pp. vii-viii, and Wilford et al. 1969: p. 51). The Kathio Focus people practiced secondary burials in mounds which were sometimes accretional and added very few, if any, grave goods (Johnson 1973: p. 66 and Wilford et al. 1969: p. 15). These people, as well as those of the Blackduck Culture, were primarily hunters and gatherers. Although no sites belonging to the Kathio Focus have been noted in the research area, it is possible that 32GG1 could belong here rather than to the Laurel Culture.

Another Late Woodland Complex in northern Minnesota is characterized by Sandy Lake pottery (Cooper and Johnson 1964). Sites associated with Sandy Lake ceramics are included in the Wanikan Culture, which

is one of the most recent Late Woodland cultures in Minnesota, dated between 950 and 250 B.P. (Birk 1977: p. 31). Essentially, it is characterized by cord-roughened, shell-tempered Sandy Lake pottery, small triangular projectile points, fire hearths and pits, prepared ricing jigs or threshing pits, intrusive mound burials, exclusive circular conical mounds with shallow burial pits, primary flexed inhumations, seasonally occupied sites, and the inferred use of wild rice (Birk 1977: p. 32).

Basically, this marks the end of Woodland tradition domination in the northeastern Plains. However, Woodland-based cultures did continue to coexist, at least early on, with groups belonging to the Mississippian Plains Village Tradition.

Mississippian Plains Village Tradition

This tradition is assumed to have started around 1000 B.P. and lasted until 100 B.P. Mississippian centers which apparently influenced developments in the northeastern Plains were established by 1000 B.P. along the central and upper Minnesota River and near the confluence of the Cannon and Mississippi Rivers in Minnesota (Johnson 1969: p.21). With the increase in Mississippian influences in these areas, a number of "Southern Cult" materials begin to appear (Johnson 1973: p. 66), including the spirally decorated pottery and other materials found in the Heimdal (32WE401) and Wray Mounds. Similar materials have been noted in other areas of the northern Plains (Howard 1953: p. 130). However, dates for this material are lacking.

By 1000 B.P., the cultures of the Plains Village (Mississippian) tradition had appeared in the Missouri Trench and possibly in the research area, considering the 1195 B.P. date of 32RM201. However, most of the sites belonging to this tradition in the research area probably appeared somewhat later in time.

Documented evidence for Mississippian groups along the eastern periphery of the northern Plains includes sites of the Cambria Culture, dating from about 950 to 650 B.P., and the Oneota Culture, circa 650 to 350 B.P. (Wilford 1970: p. viii). These groups were primarily settled village agriculturalists. There is some evidence of the presence of Oneota groups in southeastern North Dakota (Nelson 1973: p. 76), but none has been found in the research area.

Of the Middle Missouri *Plains* Village groups, the Mandan had a traditional belief that they moved from the Devils Lake area to the Middle Missouri. Whether or not this is actual fact, the pottery from an effigy mound (32ED3) in the research area has been considered very similar to Mandan (Cooper 1947: pp. 5-6). Another possible village site, 32BE3, had pottery which generally resembled material from the Middle Missouri (Cooper 1947: p. 4).

Remaining material from the research area with Middle Missouri Plains Village relationships dates to the Post-Contact Coalescent. Biesterfeldt, 32RM1, is a possible Cheyenne village that includes associated European trade goods. Other sites such as 32CS101, Schultz, Groff, and Joe Wall are village sites of unknown cultural affiliation. However, they most likely date to the same time as the Plains Village Tradition. The exact nature of these occupations and determinations of their cultural affiliation will have to await further investigations.

The Late Nomadic period is an infrequently used term referring primarily to that period of time during which certain groups gained the majority of their subsistence by hunting bison from horseback. Tipi ring sites are believed to be evidence of the existence of these groups (Nicolai et al. 1977: p. 28).

SUMMARY OF THE HISTORIC PERIOD IN THE SHEYENNE RIVER BASIN

The historic period has been divided into three units for ease of discussion: the Fur Trade (1738-1860), Military (1860-1870) and Settlement (1870-1900).

Fur Trade Period

Although the Fur Trade Period in the Sheyenne River valley begins with La Verendrye's expedition to visit the Mandan in 1738, extensive activity probably did not begin until the early 1800's. La Verendrye's influence in the research area was minimal; his route to the Mandan villages crossed the upper Sheyenne near its headwaters (Robinson 1966: p. 89).

The Biesterfeldt site, which dates from this same general time period, also received minimal contact. White influence at the site can be seen in the presence of horse bones, glass beads, and various objects of brass, steel, and iron (Wood 1971: pp. 39-42). Although metal tools such as axes, hatchets, knives, and projectile points were present, many tools of stone (projectile points, end scrapers, hammers) and bone

(hoes, fleshers) as well as pottery vessels were still being manufactured (Wood 1971: pp. 33-42, 49). This suggests that white influence was not of major importance in the late 18th century.

By 1800, most of the area from Wahpeton to the Turtle River was a no-man's land disputed by the Chippewa and Dakota (Robinson 1966: p. 56). Both groups hunted the area, however, with at least the Chippewa occasionally building fortified hunting camps (Hickerson 1962: pp. 25-27). Although the dispute between the Chippewa and Dakota may have promoted white inactivity in the area, it was not the sole cause. Most of eastern North Dakota produced poorer quality furs than did areas to the west and north, so there was less incentive for fur companies to build posts (Robinson 1966: p. 58). However, trade eventually increased in the area as a result of the need to more intensively exploit bison, both for hides and to feed the trappers to the north and west (Robinson 1966: p. 58).

Around 1805, the Michilimackinac Company gained control of trade on the Red River south of the Sheyenne River, with the Northwest Company apparently retaining control of the area to the north (Robinson 1966: p. 57). The Red River Valley and its tributaries, however, did not become avenues of trade until after the Americans gained control of the Upper Mississippi River around 1820 (Robinson 1966: pp. 72-73).

Three posts are known to have existed in the area of the Sheyenne River. Hudson's Bay had a post in operation in Griggs County from 1820 to 1870 (Griggs County 1976: pp. 4-5). Joseph Renville and the Columbia Fur Company established a post in 1826 at the confluence of the Sheyenne

and Red Rivers. After 1826, the American Fur Company, under Sibley and Kittson, controlled much of the trade in the area (Robinson 1966: p. 73) and in 1834 established a post in what appears to be the same general area of the Hudson Bay post (Gilman 1970: pp. 125, 128-129).

The trails used by the fur traders are less well known. A portion of the one used by Hudson's Bay is located in Griggs County (Griggs County 1976: pp. 4-5). Trails used by the Red River carts around 1840 to carry material between Pembina, North Dakota, and St. Paul, Minnesota, had crossings at the foot of the Sheyenne delta near Kindred, North Dakota, and at Nolan's Crossing (Sherrod 1970: p. 38). The trail also crossed the Maple River at the Maple Creek Crossing (North Dakota State Historical Society 1965).

The Fur Trade Period began to decline in 1837 after the small-pox epidemics and because the numbers of furbearing animals decreased. The end was brought about by the Indian wars of the 1860's and the resulting reservation policies (Robinson 1966: p. 106).

Military Period

Around 1820, the U.S. Government began to build or to support the building of military and trade posts in North Dakota because of an increase in Indian hostility. At the same time, the Government also began sending various military expeditions to North Dakota.

In 1839, the Nicollet-Fremont mapping expedition explored portions

of the Sheyenne River area. Camps made by this expedition include Birch Creek, where a council was held with an Indian leader named Wahnetah; the upper branch of the Maple River; and the south side of the Sheyenne River in Nelson County (North Dakota State Historical Society 1965, Page Community 1958: p. 19, and Schweigert n.d.: p. 52). Crossings of the Sheyenne River by this expedition were made a few miles below Valley City, North Dakota, and between Fort Ransom and Lisbon, North Dakota (Arnold 1918: p. 27 and Page Community 1958: p. 19).

The opening of the Oregon Territory and the discovery of gold in Montana increased white activity in the area. Sumner's expedition to Devils Lake in 1845 crossed the Sheyenne River in the area of its southermost bend, as did one of the routes to the Oregon Territory (Arnold 1918: pp. 31-32). The Pope and/or Woods expedition of 1849 crossed the Sheyenne somewhere further to the east (Page Community 1958: p. 19). The Stevens 1861 survey party crossed the Sheyenne River in northern Barnes County at what would later be known as Sibley's Crossing (Page Community 1958: p. 21).

In 1862, the Sioux killed several hundred whites in Minnesota, and the U.S. Army began to conduct military reprisals under the direction of Sibley and, later, Sully (Robinson 1966: p. 100). These reprisals, which lasted into the late 1860's, eventually extended into North Dakota, with action in eastern North Dakota directed toward the Devils Lake area. This is the best known episode of North Dakota military history.

A large number of campsites can be assigned to the above expeditions. Most were occupied only for a day or two. However, Camp Hayes was occupied for about a week and Camp Atchison, which served as Sibley's base camp, was occupied for about one month (Arnold 1918: p. 34, North Dakota State Historical Society 1965). Most of the camps were in the vicinity of the Sheyenne River, with the exception of Camps Arnold, Stephens, and Ambler, which were in the Maple River area.

In addition to camps, there are several other military sites in the area. Schweigart (n.d.: pp. 45-46) has concluded that 32BE3, which has been considered a prehistoric site by all other authors, may be a trenchwork associated with an 1865 camp of the Third Illinois Calvary. The University of North Dakota site lead files noted another trenchwork in Nelson County and an earthen embankment with rifle pits in Ransom County. Both of these sites are of unknown date and affiliation.

There are four possible battle sites noted for the area. One is the site of an 1862 battle with the Sioux near Valley City, North Dakota (Andreas 1884). For the second, in Ransom County, there is no information except that soldier burials occurred on the east side of the Sheyenne River (Andreas 1884). The University of North Dakota site lead files list two battles in Barnes County, but no other information is available. Other sites dating to this period include portions of trails and soldier burials.

In 1864, the military began establishing a series of forts to control

Indian behavior. Fort Ransom was established on the Sheyenne River in 1867 to guard a trail from Fort Abercrombie to the Missouri River (Robinson 1966: p. 102). The fort occupied an area of about 300 x 200 feet, with log buildings, earthworks, and two block houses, but no palisades (Arnold 1918: p. 36). In 1872, Fort Ransom was replaced by Fort Seward at Jamestown, North Dakota (Robinson 1966: p. 102).

There were two major military trails within the research area. One trail leads from Fort Abercrombie directly to Fort Totten, with one crossing of the Sheyenne River at Nolan's Crossing, a second in the vicinity of Sibley's Crossing, and a third near Sheyenne Crossing-5 (Sherrod 1970: p. 39, Robinson 1966: p. 89). Also, there were two crossings of the Maple River (Robinson 1966: p. 89). In addition, one ford--Shinford or Shenford--has been noted for this trail (Enderlin Diamond Jubilee Committee n.d.).

The second trail ran from Fort Abercrombie to Fort Ransom and from Fort Ransom to just above Baldhill Creek, where it joined the Fort Abercrombie-Fort Totten trail. The Fort Abercrombie-Fort Ransom Trail had two routes: one apparently proceeded from the area of Nolan's Crossing and cut across the Sheyenne River just below and above the southernmost bend, while the other followed directly along the south side of the Sheyenne River. The route from Fort Ransom to its juncture with the Fort Abercrombie-Fort Totten Trail involved one crossing of lower Baldhill Creek (Robinson 1966: p. 89). Portions of these trails are still visible.

After the replacement of Fort Ransom by Fort Seward, the Brenner Crossing of the Sheyenne River became important (North Dakota State Historical Society 1965).

There were also a series of trails and mail stations maintained on these routes. In addition to mail carriers, these generally had at least an attendant and sometimes a guard (Sherrod 1970: pp. 41-42, Schwiegert n.d.: pp. 51-52). People who died while traveling were usually buried nearby. Stiles (1951: p. 4) notes a series of such burials near Maddock, North Dakota. Ambushes also occurred on these trails, with one noted at Lyle Hill, north of Harvey, and a second at Palmer's Spring on the Fort Totten-Fort Stevenson Trail (Stiles 1951: p. 4, North Dakota State Historical Society 1965).

The University of North Dakota site lead files listed two other historic sites of unknown date and significance.

Settlement Period

White settlement of the research area gradually increased after the Civil War. In 1871, however, settlement became more pronounced in response to the railroads reaching the Red River, an increase in steamboat service on the Red River, an extension of stage services, the opening of a land office at Pembina, North Dakota, and the surveying of section lines near Fargo and Wahpeton, North Dakota (Robinson 1966: p. 129).

During the early 1870's, much of the Lower Sheyenne was settled by Norwegian farmers (Robinson 1966: p. 130). Some of the abandoned home-

steads in the area probably belonged to these farmers.

In addition, the extension of the railroads into North Dakota brought about the creation of many towns (Sherrod 1970: pp. 43-44). However, many of these towns were built in anticipation of the railroad, and, if it took another route, they were abandoned. One such town was Mardell, in Griggs County (Robinson 1966: p. 154). Owego Colony was a similar settlement, established in anticipation of the Northern Pacific Railroad. However, a Sioux scare resulted in its abandonment and destruction (Sherrod 1970: pp. 43-44).

A series of stage and mail stations were also established during this period (Griggs County 1976: Frontispiece). The Sheyenne Crossing Mail Station (32BE414) continued to be used into the 1880's (Schweigert n.d.: pp. 51-52).

Bonanza farming appeared in the 1870's as a response to the bankruptcy of the railroads (Robinson 1966: p. 137), putting large tracts of land into production by the intensive use of many laborers. Power's Helendale farm was one such farm (Sherrod 1970: p. 45), with others located near Casselton, North Dakota, in the Maple River drainage, and in Wells, Foster, Richland, and Barnes Counties (Robinson 1966: pp. 137-138). By the turn of the century, however, most of these farms had been split into smaller holdings or soon would be (Robinson 1966: p. 139).

North Dakota experienced a great boom in population during the 1880's, possibly as a response to the rapid industrialization of the American economy (Robinson 1966: p. 130). It was during this time that many homesteads began to appear in the State (Robinson 1966: pp. 148-151). Schweigert (n.d.: p. 69) noted that, within the area he was researching, the U.S. General Land Office Survey Maps from 1875 to 1903 indicated the existence of 230 homesteads or dwelling sites. On the upper Sheyenne, these sites tend to be on the first river terrace (Schneider 1976: p. 7).

Many of the old mills in the area were built about this time (Andreas 1884; Griggs County 1976: Frontispiece). The Old Lee Mill in Griggs County, for example, was in use from 1877 to 1902 (Griggs County 1976: Frontispiece).

Several churches date to this period, and many also have cemeteries (Sherrod 1970: p. 46). The Fargo Genealogical Society has compiled a list of old cemeteries in several counties.

After 1915, North Dakota began to steadily lose population. This was marked by the abandonment of several schools from 1910 to 1929 (Anonymous 1929). Some of the church cemeteries were also abandoned at this time (Sherrod 1970: p. 46).

EXISTING CONDITIONS - PREHISTORIC

There are a total of 265 previously recorded prehistoric archaeological sites and 125 prehistoric site leads in the Sheyenne River basin.

Of the known sites, 118 are located in the upper Sheyenne, with 84 located in the lower and 65 in the middle Sheyenne River basin.

The majority of these sites fall into one of the following categories: Tipi Rings, Rock Cairns, Campsites, or Mound sites. The remaining are small lithic scatters, habitation sites, or miscellaneous sites such as earthen embankments, butchering areas, rock alignments, depressions, or pictographs. Most of these site-type identifications are tentative, and are based only on reconnaissance level surveys. Three of the four most common site types in the basin, Tipi Rings, rock cairns, and mounds, are very visible and are therefore more easily located. This may account for the larger percentage of these types of known sites in the basin.

In addition, the majority of the sites in the basin have been assigned a broad Woodland cultural affiliation. This is most likely based on the level of survey at which the sites were identified. The kind of information necessary for determining exact cultural affiliation is usually not collected at a reconnaissance level survey. The significance of the sites mentioned above is unknown pending additional testing work.

As of 30 March 1981, there is one archaeological site in the Sheyenne River basin listed on the National Register of Historic Places. This site, the Biesterfeldt (32RM1), is the only extensively excavated site in the basin and is very significant because of its ties with the ethnographic Cheyenne. Further surveys and testing are likely to yield additional significant sites in the basin.

Most of the sites in the basin have been disturbed by cultivation. However, this does not negate their significance, because subsurface materials and features may still exist. Even sites that have been completely destroyed by plowing can still yield significant cultural information through controlled surface collecting.

A listing of known prehistoric sites is available in table 1.

EXISTING CONDITIONS - HISTORIC

There are 54 previously recorded historic sites and 60 sites leads in the Sheyenne River basin. The majority of these are either associated with the military or are abandoned farmsteads, although sites also exist that are associated with the fur trade, early expeditions, abandoned towns, and early churches and cemeteries.

Most of the sites date from the 1860's to the late 1800's. Not much is known about historic sites in the basin because little research and few surveys have been conducted that emphasize the early historic nature of the area.

Most of the historic sites were discovered only through literature searches and have not been field checked. Those that have been located in the field were simply noted in most cases, because the surveys were emphasizing prehistoric sites.

A standing structure inventory of the Sheyenne River basin has not been undertaken to date. As of 30 March 1981, there are five historic

standing structures and one historic district within the Sheyenne basin between West Fargo and Devils Lake which are listed on or eligible for the National Register. A standing structure survey of the basin will most likely identify other significant properties.

A listing of known historic sites is available in table 2.

NATIONAL REGISTER OF HISTORIC PLACES

There is one archaeological site (21RM1) within the Sheyenne River basin listed on the National Register of Historic Places. This is the Biesterfeldt Site, a fortified village of approximately 60 earth lodges located in Ransom County in eastern North Dakota. The site is composed of a large, central earth lodge facing a central plaza and surrounded by randomly placed structures. It sits on a high river terrace near an abandoned bend in the Sheyenne River channel, at an elevation of 325 meters above sea level.

The site has been associated with the semisedentary Cheyenne, and the setting, village plan, and structures are similar to those of the historic Mandan. The assigning of the site to the protohistoric Cheyenne cultural affiliation is not definitive, although it has been strongly postulated by Strong (1940) and Wood (1971).

Artifacts from this site, which dates from about 1750 to 1790 A.D., are of a Plains Village pattern, with many trade goods replacing the more traditional tools of bone and stone.

There have been two research projects involving the Biesterfeldt

Site. The first was an excavation by W.D. Strong conducted in the summer of 1938. This is the only major excavation at the site to date, and most later work is based extensively on his research. The results of this excavation have never been formally published by Strong, although they are briefly summarized in his book entitled From History to Prehistory in the Great Plains.

The only other research on the site was conducted by W.R. Wood, who published a ceramic analysis of the site in 1955, based on collections from Strong's excavation. In 1971, Wood published a report entitled Biesterfeldt: A Post-Contact Coalescent Site on the Northern Plains. This report is also based on Strong's 1938 work and is the most definitive work to date on the site.

In addition to one archaeological site, there are five historic standing structures and one historic district on the National Register of Historic Places along the Sheyenne River, all within incorporated towns. These sites are:

(1) Griggs County Courthouse
Rollins Avenue, Cooperstown, Griggs County

(2) Lisbon Opera House
413 Main Avenue, Lisbon, Ransom County

(3) Valley City Carnegie Library
413 Central Avenue, Valley City, Barnes County

(4) Ramsey County Sheriff's House
420 6th Street, Devils Lake, Ramsey County

(5) U.S. Post Office and Courthouse

502 4th Street, Devils Lake, Ramsey County

(6) T.J. Walker Historic District

at Sheyenne River, Fort Ransom, Ransom County

DATA GAPS

Because of the level of surveys undertaken to date in the Sheyenne River basin, there are many areas where data on cultural resources is lacking. Reconnaissance level surveys are not usually detailed enough to allow for definitive statements on site type, cultural affiliation, or settlement patterns. Thus, additional surveys will be necessary as planning proceeds in order to collect detailed diagnostic information on cultural resources in the basin.

Perhaps the most significant data gap in the Sheyenne River basin involves protohistoric and historic sites. There have been no historic archaeological or historic standing-structure surveys conducted to date in the basin. Cultural resource surveys will need to be conducted during future planning stages in order to systemmatically identify and evaluate historic sites in the project area.

Other possible research related data gaps are listed below. These, however, are only a few of the multitude of research topics and hypotheses that could shed additional light on the cultural patterns of the Sheyenne River basin:

(1) Cultural affiliation of sites

(2) Site type identification

(3) Settlement patterns

(4) Resource procurement

(5) Lithic procurement

(6) Existence of deeply buried sites

(7) Archaic site location

(8) Mississippian influences in the basin

(9) Ceramic typology

FUTURE STUDY NEEDS

Additional cultural resource surveys are necessary in the Sheyenne River basin in order to identify new sites, verify site leads, and collect additional detailed information on previously recorded sites. These surveys will be conducted for the selected alternative and will include not only additional prehistoric archaeological surveys, but historic archaeological and historic standing structure surveys as well.

Intensive testing will be undertaken for those sites that will be affected by the selected alternative in order to determine if they are eligible for inclusion on the National Register of Historic Places. All listed or eligible sites will be mitigated in accordance with the Advisory Council on Historic Preservation guidelines, 36 CFR, Part 800. All mitigation work will be accountable as part of the 1-percent limitation in accordance with the Reservoir Salvage Act, as amended. Depending on the extent of significant resources that may be impacted, a request to exceed the 1-percent limitation may be necessary as provided by Public Law 93-291.

Table 1 - Known Prehistoric Sites

Site Number	Elevation	Site Type	Cultural Affiliation
32BA1		Mounds	
2		Camp	
3		Camp	
4		Mounds	
5		Occupation	
6		Occupation	
7		Camp	
8			
11		Mound and Earthworks	
14	1270	Lithic Scatter	
15	1260-1300	Lithic Scatter	
401		Camp	
403	1280	Burial	
405	1260		
406	1260-1280		
407	1300	Rock Cairns	
408	1260-1300	Lithic Scatter	
409	1370	Mound	Woodland (?)
410	1380	Mounds	Woodland
411	1280-1300	Lithic Scatter	
412	1330	Lithic Scatter	
413	1266	Habitation	Woodland
414	1270	Occupation	
415	1280	Lithic Scatter	
417	1266-1275	Lithic & Bone Scatter	
418	1266-1275		
420	1270	Lithic & Ceramic Scatter	Woodland
421	1270	Lithic & Ceramic Scatter	Woodland
422	1270-1290	Lithic Scatter	
423	1280	Lithic Scatter	
424	1280-1300	Historic Homestead & Prehistoric Lithic Scatter	
425	1260-1280		
427	1270-1280		
428	1280-1300	Butchering Area (?)	
32BE3		Village & Trenchwork	Missouri River
4		Mound	
5		Mound	
6		Camp	
7		Camp	
203		Mound & Rock Alignment	
204		Tipi Rings	
205		Tipi Rings	
206		Tipi Rings	
207		Rock Cairns	

[illegible] - Known Prehistoric Sites (Cont'd)

Site Number	Elevation	Site Type	Cultural Affiliation
[illegible]		Mound	Woodland
[illegible]	[illegible]	Camp	Woodland and Mississippian (?)
[illegible]	[illegible]	Camp	Late Woodland(?)
[illegible]	[illegible]	Camp	Woodland w/Mississippian & Historic (?)
[illegible]	[illegible]	Camp	Woodland w/Mississippian (?)
[illegible]	[illegible]	Camp	Woodland (?)
[illegible]		Camp	
[illegible]		Camp	
[illegible]		Mound	Missouri River
[illegible]		Mounds	
[illegible]		Camp	
[illegible]		Camp	
201		Mound	
[illegible]		Camp	
[illegible]		Camp	
[illegible]		Mounds & Tipi Rings	
404		Mound	
[illegible]			
2	>1266	Occupation	
3	>1266	Occupation	
5	1290	Habitation	
7	1280	Lithic & Ceramic Scatter	Woodland
9	1275	Lithic & Ceramic Scatter	Woodland
10	1280-1300	Prehistoric Lithic Scatter & Historic Structure	
11	1260-1280		
12	1300	Lithic & Ceramic Scatter	Woodland (?)
13	1260-1280		
14	1270	Historic Habitation & Prehistoric Lithic Scatter	
15	1285	Lithic Scatter	Woodland
17	1280-1290	Occupation	Woodland (?)
18	1270	Lithic Scatter	Woodland
19	1280	Lithic Scatter	Woodland (?)
221	1275	Camp	Woodland
222	1295	Camp	Woodland
223	1281	Camp	Woodland
224	1375	Mound	Woodland
225	1280	Camp	Woodland
226	1410	Mound	Woodland
227	1290	Camp	Woodland
228	1305	Mound	Woodland

Table 1 - Known Prehistoric Sites (Con't)

Site Number	Elevation	Site Type	Cultural Affiliation
32GG229	1280	Camp	Woodland (?)
230	1290	Slablined Dugout	Late 1800's
231	1295	Camp	Woodland
232	1291	Camp	Woodland
233	1291	Camp	Woodland
234	1290	Camp	Woodland (?)
235	1290	Camp (?)	Late Prehistoric
236	1271	Camp (?)	
32NE101			
410		Mounds	Woodland
411		Mounds	Woodland
412		Mounds	
413		Mounds	
32RM1*		Village	Cheyenne
101		Mounds	
102		Rock Alignment	
103		Rock Holes	
104		Pictograph	
105		Rock Alignment	
106		Mounds	Plains Woodland
107		Camp	Late Nomadic
201		Burial	Middle Missouri
202	1025	Camp	Woodland (?)
203	1075	Camp	Woodland (?)
204	1017	Camp	Mississippian and Woodland (?)
205	1091	Camp w/2 Burials (?)	Woodland (?)
206	1050	Camp	Woodland (?)
207	1005	Mound	Woodland (?)
208	1010	Camp	Woodland
209	1000	Camp	Mississippian(?)
210	1004	Camp	Late Woodland (?)
211	1000	Earth Lodge Village (?)	Late Prehistoric
212	1000	Camp	Late Prehistoric
213	1000	Camp	Late Prehistoric
214	1000	Camp	Late Prehistoric
215	990	Camp	Late Prehistoric
217	1156	Mound	Woodland
218	1150	Mound	Woodland
219	1125	Mound	Woodland
220	1135	Mound	Woodland
222	1150	Mound	Woodland
223	1130	Village w/Earthlodge Depressions	Late Prehistoric
224	1130	Mound	Woodland (?)
225	1150	Circular Entrenchment	

Table 1 - Known Prehistoric Sites (Con't)

Site Number	Elevation	Site Type	Cultural Affiliation
[illegible]EM226	1056	Camp	Woodland (?)
227	1125	Tipi Rings	Late Prehistoric
228	1145	Mound	Woodland
2[illegible]	1070	Camp	Woodland
[illegible]1	1080	Camp	Woodland (?)
[illegible]2	1175	Mound	Woodland (?)
[illegible]	1175	Mound	Woodland (?)
[illegible]4	1205	Camp	Archaic (?)
2[illegible]	1030	Camp	Woodland or Mississip- pian
2[illegible]	1050	Mound	Woodland
237	1210	Lithic Scatter	Archaic (?)
238	1200	Lithic Scatter	Archaic (?)
239	1205	Lithic Scatter	Archaic (?)
240	1200	Lithic Scatter	Archaic (?)
401		Trenchwork	
402		Trenchwork	
32SH1		Tipi Rings	
2		Tipi Rings, Rock Cairns and Alignment	
3		Camp	
4		Camp	
5		Tipi Rings	
6		Bison Kill	
7		Bison Kill	
8		Camp	Woodland
101		Tipi Ring	
102		Rock Cairns	
103		Camp	
104		Rock Cairns	
105		Tipi Ring	
107		Rock Cairn	
108		Tipi Rings	
109		Rock Cairn	
110		Depression	
111		Rock Cairn	
112		Tipi Ring & Rock Cairns	
113		Rock Cairn	
114		Camp	
115		Camp	
116		Tipi Ring	
117		Tipi Ring & Rock Cairns	
118		Camp	
121		Rock Cairn	
122		Rock Cairns	
124		Rock Cairn	
126		Tipi Ring	

Table 1 - Known Prehistoric Sites (Con't)

Site Number	Elevation	Site Type	Cultural Affiliation
42BH127		Tipi Rings & Rock Cairns	
128		Rock Cairns	
129		Tipi Rings	
130		Eagle Trap	
133		Tipi Rings	
134		Tipi Rings & Rock Cairns	
135		Tipi Rings & Rock Cairns	
136		Tipi Rings	
137		Rock Cairns	
138		Rock Cairns	
140		Tipi Rings	
141		Tipi Rings	
142		Camp	
144		Rock Cairns	
145		Tipi Rings & Rock Cairns	
146		Tipi Rings & Rock Cairns	
147		Tipi Rings & Rock Cairns	
148		Tipi Rings	
149		Tipi Rings	
151		Tipi Rings & Rock Cairns	
152		Tipi Rings	
153		Tipi Rings & Rock Cairns	
154		Tipi Rings	
155		Tipi Rings	
156		Tipi Rings	
157		Tipi Rings	
158		Tipi Rings	
159		Tipi Rings & Rock Cairns	
160		Tipi Rings	
161		Tipi Rings	
162		Tipi Rings	
163		Tipi Rings	
164		Tipi Rings & Rock Cairns	
166		Tipi Rings	
167		Rock Cairns	
168		Rock Cairns	
169		Rock Cairns	
170		Rock Cairns	
171		Rock Cairns	
172		Rock Cairns	
173		Rock Cairns	
174		Rock Cairns	
175		Rock Cairns	
176		Rock Cairns	
177		Rock Cairns	
201		Tipi Rings & Rock Cairns	

Table 1 - Known Prehistoric Sites (Con't)

Site Number	Elevation	Site Type	Cultural Affiliation
[illegible]		Tipi Rings & Rock Cairns	Woodland
[illegible]		Tipi Rings & Rock Cairns	
[illegible]		Tipi Rings	
[illegible]		Mound	
[illegible]		Rock Cairns	
[illegible]		Tipi Rings	
[illegible]		Tipi Rings	
[illegible]		Tipi Rings, Rock Cairns, & Rock Alignment	
[illegible]		Tipi Rings	
[illegible]		Tipi Rings & Rock Cairns	
[illegible]		Camp	
[illegible]		Tipi Rings	
[illegible]		Tipi Rings	
[illegible]		Tipi Rings	
[illegible]		Tipi Rings	
[illegible]		Rock Cairns	
[illegible]		Rock Cairns	
[illegible]		Rock Cairns	
[illegible]		Rock Cairns	
[illegible]		Rock Cairns	
120		Camp	
121		Rock Cairns	
122		Tipi Rings	
123		Tipi Rings	
124		Rock Cairns	
201		Tipi Rings	
202		Tipi Rings	
203		Tipi Rings	
204		Rock Cairn & Alignment	
205		Tipi Rings	
206		Rock Cairn	
207		Tipi Ring	
208		Tipi Ring	
209		Tipi Ring	
211		Tipi Rings	
401		Mound	

* This site is on the National Register of Historic Places

Table 2 - Known Historic Sites

Site Number Or Name	Elevation	Site Type	Cultural Affiliation And/Or Date
Barnes County			
32BA424	1280-1300	Historic Homestead & Prehistoric Lithic Scatter	
426	1280	Junk Pile	1950's
Camp Weiser		Military	Post 1861
Camp [illegible]		Military	Post 1861
Camp Corning		Military	Post 1861
Camp Arnold		Military	Post 1861
[illegible] & Moore		Military Graves	Post 1861
[illegible] Log Cabin		Farmstead	
Cass County			
[illegible]	895	Homestead Dugouts	1892
Maple Creek Crossing		Fur Trade	
Birch Creek Camp		Nicollet-Fremont Expedition	
Watson's Crossing		Military	Post 1861
Sibley Trail		Military	Post 1861
Camp Johnson		Military	Post 1861
Fort Ransom-Fort Totten Trail		Military	Post 1861
Eddy County			
32ED402		Farmstead	
408		Log/Frame Structures	
Brenner Crossing		Military	Post 1861
Brenner Crossing Pioneer Cemetery		Cemetery	Pioneer
[illegible] County			
[illegible]4	1280-1300	House	Euro-American
7	1290	Farmstead	Euro-American
8	1290	Dugout	Euro-American
10	1280-1300	Historic Structure & Prehistoric Lithic Scatter	
14	1270	Historic Habitation & Prehistoric Lithic Scatter	
[illegible]	1290	Slab-Lined Dugout	Late 1800's

Table 2 - Known Historic Sites (Con't)

Site Number or Name	Elevation	Site Type	Cultural Affiliation And/Or Date
Camp Atchison		Military	Post 1861
[illegible] Wannamaker		Military Grave	Post 1861
Ransom County			
32RM[illegible]		Farmstead Dugout	
[illegible]	1050	Storm Station	1867
[illegible]	1125	Dugout	1800's
[illegible]	1085	Flour Mill	1920-30's
Fort Ransom		Military	Post 1861
Pigeon Point Trail [illegible]		Military	Post 1861
Fort Abercrombie-Fort Ransom Trail		Military	Post 1861
Owego Colony		Abandoned Town Site	
Richland County			
Nolan's Crossing		Fur Trade	
Nolan's Crossing Road Station		Military	Post 1861
Power's Helendale Farm		Bonanza Farm	
Zion Lutheran Church & Cemetery		Church & Cemetery	
Barrie Lutheran Church & Cemetery		Church & Cemetery	
Sheridan County			
32SH106		Farmstead Dugout and Root Cellar	
119		Farmstead Dugout	
120		Farmstead Dugout	
123		Farmstead Dugout	
125		Farmstead Foundation	
131		Farmstead Structures and Foundation	
132		Farmstead Structures and Foundation	
139		Farmstead Foundation	
143		Farmstead Foundation	
150		Farmstead Foundation	
165		Farmstead Foundation	

Table 2 - Known Historic Sites (Con't)

Site Number Or Name	Elevation	Site Type	Cultural Affiliation And/Or Date
Wells County			
32WE104		Farmstead Structures and Dugout	
112		Farmstead Structures and Foundation	
210		Farmstead Foundation	

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APPENDIX F

SOCIOECONOMIC AND INSTITUTIONAL ANALYSIS

GENERAL REEVALUATION

AND

ENVIRONMENTAL IMPACT STATEMENT

SHEYENNE RIVER, NORTH DAKOTA

AUGUST 1982

APPENDIX F

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SOCIOECONOMIC ANALYSIS

INTRODUCTION

This socioeconomic analysis describes the Sheyenne River study area and its people by presenting current and historical data. Many of the statistics are standardly reported on a national basis and so provide a comparable portrait of the area's social setting and its economic life and growth or decline. Some details are noncomparable; however, for they describe unique characteristics of the region. Taken together, these data should provide a basis for assessing the significance of the flooding problems to the human population and for evaluating society's ability and willingness to solve those problems.

POPULATION

Past Trends

The lower Sheyenne River basin, the part of the study area most directly affected by flooding, consists of parts of Cass, Richland, Ransom, and Barnes Counties. Table F-1 shows the population of the study area from 1950 to 1980. The area's population increased 3.2 percent, compared to an increase of 5.3 percen_ in the population of the State of North Dakota for this time. During this period, both Barnes and Ransom Counties suffered population declines, Cass County experienced substantial increases, and Richland County appears to have stabilized. Generally, urban areas increased while rural areas declined in population. The most rapidly growing city in the lower basin, West Fargo, recoreded a population growth of 846.3 percent between 1950 and 1980.

The 1980 census data indicate that some of the past downward population trends in North Dakota may have changed. Cass and Richland Counties have grown in population as a result of expansion in the urban areas, and the rate of decline in some of the other counties has slowed.

Table F-1
Population, Shevenne River study area

Location	1950	1960	1970	1980	1990	2000	2010	2020	2030	2040
North Dakota	619,636	632,446	617,761	652,437	655,364 (1)	661,880				
Cass County	58,877	66,947	73,653	88,243	95,767 (1)	102,548	114,058	125,671	137,535	149,878
Fargo	38,256	46,662	53,365	61,281	66,700 (1)	71,388	81,000	90,500	99,500	109,400
Horace	190	178	276	497	556 (1)	696	840 (3)	1,000	1,100	1,200
West Fargo	1,191	3,421	5,265	10,080	13,000 (1)	15,500	17,800 (2)	20,200 (2)	23,500	26,400
Argusville	126	118	118	147	147 (4)	147	147	147	147	147
Gardner	136	107	96	117	117 (4)	117	[illegible]	117	117	117
Harwood	165	172	224	326	356 (2)	409	463	516	570	623
Riverside	-	-	-	465	600 (5)	600	600	600	600	600
Reile's Acres	-	-	-	191	191 (4)	191	191	191	191	191
Balance of County	18,813	16,289	14,309	15,139	14,100 (6)	13,500	12,900	12,400	11,800	11,200
Lisbon	2,031	2,093	2,090	2,286	2,300 (2)	2,400	2,500	2,500	2,600	2,700
Valley City	6,851	7,809	7,843	7,771	8,300 (2)	8,500	8,800	9,100	9,400	9,700
Barnes County	17,884	16,719	14,669	13,949	13,300 (7)	12,700	12,300	12,000	11,800	11,700
Ransom County	8,876	8,078	7,102	6,714	6,624 (1)	6,477	6,230 (3)	6,000	5,800	5,600
Richland County	19,865	18,824	18,089	19,197	19,100 (6)	19,300	19,400	19,600	19,800	20,000

1950-1980 data is from the U.S. Census. 1980 data is preliminary.
1990-2040 data is derived from the following sources (cited for first entry only):

(1) State of North Dakota recommended projections.
(2) Linear regression, 1950-1980 trend line.
(3) Linear regression, 1970-2000 using State projections.
(4) Too small to project change.
(5) Based on available residential land existing boundaries.
(6) Linear regression, 1960-1980.
(7) Linear regression, log of the non-Valley City portion of the county from 1960 to 1980 plus Valley City.
(8) Based on 1980 preliminary census.

Table F-2 Population projections for 1980 and 2000, Fargo-Moorhead BEA area 97 and SMSA comparison to other population projections

					1980 ESTIMATED POPULATION					YEAR 2000 ESTIMATED POPULATION				
AREA	1950 CENSUS	1960 CENSUS	1970 CENSUS	PRELIMINARY 1980 CENSUS	OBERS SERIES E	OBERS SERIES C	RECOM-MENDED STATE (1)	HIGH STATE (2)	FARGO-MOORHEAD METROPOLITAN COUNCIL OF GOVERNMENTS (4)	OBERS SERIES E	OBERS SERIES C	RECOM-MENDED STATE (1)	HIGH STATE (2)	FARGO-MOORHEAD METROPOLITAN COUNCIL OF GOVERNMENTS (4)
BEA AREA 97	339,028	338,500 (3)	335,411	357,679	324,700	347,600	339,127	344,662	--	306,700	388,000	343,413	356,253	--
FARGO-MOORHEAD SMSA	89,240	106,027	120,238	137,493	126,400	NA	131,766	132,770	135,000	128,000	163,000 (3)	145,140	150,656	157,000
AS PERCENT OF BEA	26.3	31.3	35.8	38.4	38.9	NA	38.9	38.5	--	41.7	42 (3)	42.3	42.3	--
CASS CO., N.D.	58,877	66,947	73,653	88,243			79,966	80,970				85,240	90,756	
AS PERCENT OF SMSA	66	63	61	64			61	61				59	60	
CLAY CO., MN	30,363	39,080	46,585	49,250			51,800	51,800				59,900	59,900	
AS PERCENT OF SMSA	34	37	39	36			39	39				41	40	
FARGO	38,256	46,662	53,365	61,281			60,975					71,388		
AS PERCENT OF SMSA	43	44	44	45			46					49		
WEST FARGO	1,191	3,421	5,265	10,080			10,100					15,500		
AS PERCENT OF SMSA	1	3	4	7			8					11		
MOORHEAD	14,870	22,934	29,687	29,925			NA					NA		
AS PERCENT OF SMSA	17	22	25	22			--					--		

(1) Populations for Minnesota are those that appear in the November 1975 publication "Minnesota Population 1975-2000." Populations for North Dakota are taken from the Agricultural Economics Statistical Series, Issues No. 27 and 28, and assume one-half the 1960 and 1970 migration rate and 2.1 fertility rate, as recommended by the preparers. Projections for the BEA and SMSA are aggregated county projections.

(2) The same sources are used as in footnote 1, only the assumptions for North Dakota are one-half the 1960-1970 migration rate and a 2.5 fertility rate.

(3) Estimated at 42 percent of the area.

(4) Taken from "Metropolitan Land Use Element," Fargo-Moorhead Council of Governments, August 1978, p. 6.

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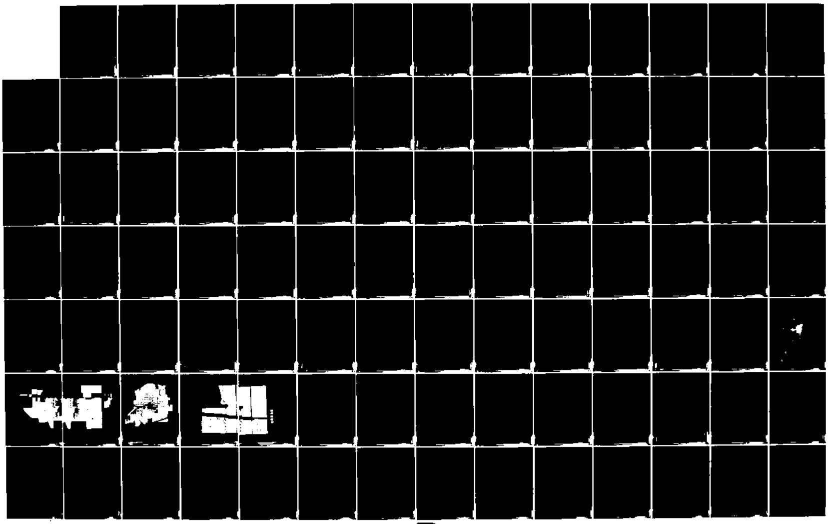

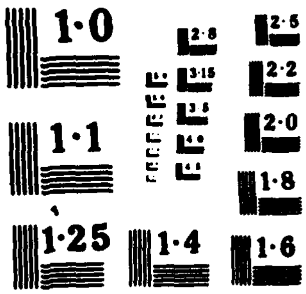
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Table F-2 Population projections for 1980 and 2000, Fargo-Moorhead BEA area 97 and SMSA comparison to other population projections

AREA	1950 CENSUS	1960 CENSUS	1970 CENSUS	PRELIMINARY 1980 CENSUS	1980 ESTIMATED POPULATION: OBERS SERIES E	OBERS SERIES C	RECOM-MENDED STATE (1)	HIGH STATE (2)	FARGO-MOORHEAD METROPOLITAN COUNCIL OF GOVERNMENTS (4)	YEAR 2000 ESTIMATED POPULATION: OBERS SERIES E	OBERS SERIES C	RECOM-MENDED STATE (1)	HIGH STATE (2)	FARGO-MOORHEAD METROPOLITAN COUNCIL OF GOVERNMENTS (4)
BEA AREA 97	339,028	338,500 (3)	335,411	357,679	324,700	347,600	339,127	344,662	—	306,700	388,000	343,413	356,253	—
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AS PERCENT OF BEA	26.3	31.3	35.8	38.4	38.9	NA	38.9	38.5	—	41.7	42 (3)	42.3	42.3	—
CASS CO., N.D.	58,877	66,947	73,653	88,243			79,966	80,970				85,240	90,756	
AS PERCENT OF SMSA	66	63	61	64			61	61				59	60	
CLAY CO., MN	30,363	39,080	46,585	49,250			51,800	51,800				59,900	59,900	
AS PERCENT OF SMSA	34	37	39	36			39	39				41	40	
FARGO	38,256	46,662	53,365	61,281			60,975					71,388		
AS PERCENT OF SMSA	43	44	44	45			46					49		
WEST FARGO	1,191	3,421	5,265	10,080			10,100					15,500		
AS PERCENT OF SMSA	1	3	4	7			8					11		
MOORHEAD	14,870	22,934	29,687	29,925			NA					NA		
AS PERCENT OF SMSA	17	22	25	22			—					—		

(1) Populations for Minnesota are those that appear in the November 1975 publication "Minnesota Population 1975-2000." Populations for North Dakota are taken from the Agricultural Economics Statistical Series, Issues No. 27 and 28, and assume one-half the 1960 and 1970 migration rate and 2.1 fertility rate, as recommended by the preparers. Projections for the BEA and SMSA are aggregated county projections.

(2) The same sources are used as in footnote 1, only the assumptions for North Dakota are one-half the 1960-1970 migration rate and a 2.5 fertility rate.

(3) Estimated at 42 percent of the area.

(4) Taken from "Metropolitan Land Use Element," Fargo-Moorhead Council of Governments, August 1978, p. 6.

Population distribution in North Dakota has shifted from rural to urban areas since 1950. From 1950 to 1970, the State's rural population dropped from 73.4 percent to 55.7 percent of the total population. Traditionally rural in character, Barnes, Ransom, and Richland Counties followed suit (table F-2). Increasing agricultural investment costs have resulted in a movement towards larger capital-intensive farming operations, which in turn have displaced smaller, labor-intensive family farms. Consequently, a large portion of the unemployed rural population has shifted to urban areas within the basin. During this time, Fargo increased by 20 percent and Wahpeton by 28 percent.

Future Projections

Changes in historic trends since 1970 make projecting population very difficult. The Bureau of Economic Analysis (BEA), the States of North Dakota and Minnesota, and the Fargo-Moorhead Council of Governments (F-M COG) have each issued population projections for portions of the study area or for larger aggregate areas which include the study area. For comparative purposes, area-specific projections and historic data were aggregated to provide a common base. Table F-2 shows the historic and projected populations for the Fargo-Moorhead Standard Metropolitan Statistical Area (SMSA) and Fargo-Moorhead BEA area 97 (which includes the SMSA, Fargo, and Cass County in North Dakota and Moorhead and Clay Counties in Minnesota). The BEA made two projections, the OBERS Series E and Series C. Both North Dakota and Minnesota give recommended-State and high-State projections; footnotes (1) and (2) of table F-2 define and cite the sources for these projections.

The projected rates of growth from 1970 to 2000 vary considerably. For the BEA area, OBERS Series E projects a 8.6-percent decline in population for that period, while OBERS Series C projects a 15.7-percent increase.

The recommended-State and high-State projections predict the BEA area counties to increase 2.4 percent and 6.2 percent, respectively. All projection sources except OBERS Series C project population for the Fargo-Moorhead SMSA (see table F-2). The F-M COG projects the greatest population increase for the SMSA (30.6 percent). The high-State projection is a 24.5-percent increase and the recommended-State projection is a 20.7-percent increase. OBERS Series E makes the most conservative projection - a 6.5-percent growth rate. State projections show increases of 16 to 23 percent for Cass County and a 28-percent increase for Clay County.

Despite the significant differences in the projected populations, there are some similarities. The OBERS and both States' projections show the SMSA as approximately the same percentage of the BEA area in 1980 (38.9 percent OBERS, 38.9 and 38.5 State) and in 2000 (41.7 OBERS and 42.3 for both States). Both States also project their respective counties to retain about the same portion of the SMSA as in 1970.

The percentage relationships discussed above are reflected in the 1980 population for the area.

Table F-2 compares the 1980 populations to the projected populations. Linear extrapolation of the 1940 to 1980 trend for the SMSA (which gives the most consistent trend line) estimated its population by the year 2000 at 166,000. Based on the proportioning relationships used in these three projections and the historic relationships, population projections for the various areas are as follows:

Table F-3 Regression analyses of Fargo-Moorhead SMSA

Year 2000

Area	Percent Relation to SMSA	Factor	Population
SMSA	100	1.0	166,000
BEA	SMSA 42% BEA	2.381	395,000
Cass County	59.5 Projected 62 Historic	.595 .620	99,000 103,000
Clay County	40.5 Projected 38 Historic	.405 .380	67,000 63,000
Fargo	49 Projected (1) 44 Historic	.490 .440	81,300 73,000
Moorhead	23 Historic (2)	.230	38,000

(1) Historic trends are so consistent that the projections for percent change in Fargo are considered improbable.

(2) No State projections are available.

Separate least squares regression analyses on Cass and Clay Counties indicate populations for the year 2000 of 102,000 and 64,000, respectively. These figures are fairly consistent with the projected populations from table F-3. Least squares regression for Fargo indicates a population of 75,400 in 2000. Least squares regression analysis of the various parts of the area and proportioning of the area using historic or projected trends yields very similar numbers. Without any abrupt changes in society, there is no indication that the historic relationship or trends will not continue. While the preceding extrapolation table may not be completely accurate, any differences should be insignificant.

Only two of the projections made by other agencies are close to those in the preceding table: OBERS Series C and F-M COG. Projections made by the States and OBERS Series E appear to underestimate the population. A comparison with the 1980 Census shows that all projections except Minnesota's were too low.

The populations on table F-1, computed by a Corps economist, are compatible with the OBERS projections.

EDUCATION

Available Facilities

Residents of the four-county area are served by local kindergarten through 12th grade education facilities. Postsecondary educational institutions are located in the Fargo-Moorhead SMSA, including North Dakota State University, Moorhead State University, and Concordia College, as well as various business colleges. Wahpeton, located in Richland County, is the site of the North Dakota State School of Science, the largest vocational education institute in North Dakota. Although enrollments continue to increase in both NDSU and the school of science, they are declining throughout most of North Dakota's elementary and postsecondary schools. Also in

the study area, Valley City State College in Barnes County expects continuing fluctuations in enrollments, declining from 1,217 in 1980 to 785 in 1990. Traditionally a teacher's college, this institution now enrolls 40 percent of its students in business administration.

Educational Attainment

The overall educational attainment of the four-county area falls slightly below that of the State. In 1970, 27.0 percent of North Dakota's population 25 years and older had 8 years or less of education. In Barnes, Ransom, and Richland Counties, however, relatively high percentages of the population (37.4, 40.7, and 43.1 percent, respectively) had 8 years or less of school. Predominantly agricultural, these three counties provided little incentive for continuing education (1950-1970) because farming requires little formal education. In Cass County, persons with 8 years or less of education fell below the State percentage in 1970, with 24.3 percent of their population falling within this category. The percentage of those with 8 years or less of schooling in West Fargo, Cass County (24.2 percent), was consistent with the figure for the county (24.3 percent). Since 1970, West Fargo has been experiencing an influx of workers in the SMSA. This influx continues to increase the number and percent of persons with high levels of education residing in West Fargo.

In the four-county area, the percentage of population 25 years and older with a high school diploma was comparable to the State percentage (27.6 percent). The percentage of these persons ranged from 23.9 percent in Richland County to 31.4 percent in Cass County.

The U.S. Census (1970)[1] indicated fewer boys than girls attained a high school diploma. In the U.S., female farm laborers compared well with women in blue collar

[1] PC(1)-C36 North Dakota Bureau of Census, "General, Social, and Economic Characteristics," table 120.

occupations. Moreover, 65.6 percent of younger female farm laborers had finished least 4 years of high school in 1975, a figure well above the 34.7 percent recorded by their male counterparts.[1]

Of the four counties, Ransom had the lowest proportion (18.2 percent) of its population with at least some college education. Barnes and Richland Counties had 22.5 and 22.9 percent, respectively, in this category. This pattern of education consistent with the predominance of agriculture in the economy of the area. There are few significant urban concentrations of population in Barnes, Ransom, and Richland Counties which present occupations requiring postsecondary education. Cass County had the highest proportion of persons with education beyond the high school level (33.1 percent). This figure reflects the existence of numerous postsecondary educational facilities within the Fargo-Cass County section of the SMSA.

See table F-4 for additional data on educational attainment.

Future Needs

In the future, farmers will need higher levels of formal education to attain the scientific and managerial competence demanded by modern agriculture. Those with less formal education will find it difficult to compete with better educated farmers.

EMPLOYMENT

The four major labor force employers in the four-county area of the lower Sheyenne River basin in 1977 were agriculture, wholesale-retail trade, services, and government. BEA statistics indicate that from 1971 to 1977, employment in agriculture declined throughout the lower Sheyenne River basin, while employment

[1] The Education Level of Farm Residents and Workers by Frank A. Fratoe, U.S. Department of Agriculture, p. 15.

Table F-4 Education Attainment by County and State for People 25 Years and Older, 1970[1]

Educational level	Barnes		Cass		Ransom		Richland		West Fargo		N. Dakota	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
8 yrs or less	2,955	37.4	8,859	24.3	1,734	40.7	4,070	43.1	560	24.2	85,847	27.0
Some high school	965	12.2	4,041	11.1	450	10.6	953	10.1	291	12.6	35,153	11.0
High school degree	2,201	27.9	11,446	31.4	1,300	30.5	2,262	23.9	847	36.6	87,806	27.6
Some college	1,112	14.1	6,896	18.9	554	13.0	1,503	15.9	438	18.9	45,680	14.3
College degree	665	8.4	5,177	14.2	223	5.2	661	6.9	176	7.6	16,487	5.2
Total	7,898		36,419		4,261		9,449		2,312		318,339	

(1) U.S. Bureau of the Census 1970

Table F-5
Cass County, North Dakota,
Employment by Industry
(Full & Part-Time)

INDUSTRY	1971 NUMBER	1971 % TOTAL	1972 NUMBER	1972 % TOTAL	1977 NUMBER	1977 % TOTAL	PERCENT CHANGE 71-77
Agriculture (total)	2399	5.9	2292	5.5	2128	4.1	-11.30
Proprietors*	1818	4.5	1758	4.2	1625	3.1	-10.61
Wage and Salary Employment	581	1.4	534	1.3	503	1.0	-13.42
Non-agriculture (total)	38,198	94.1	39,591	94.5	49,627	95.9	29.92
Proprietors	2,203	5.4	2,200	5.3	2,555	4.9	15.98
Wage and Salary Employment	35,995	88.7	37,391	89.2	47,072	91.0	30.77
Construction	2,490	6.1	2,781	6.6	3,176	6.1	27.55
Manufacturing	2,375	5.9	2,562	6.1	4,075	7.9	71.58
Transportation & Utilities	2,687	6.6	2,616	6.2	2,943	5.7	9.52
Wholesale & Retail Trade	10,392	25.6	11,010	26.3	14,741	28.5	41.84
Finance, Insurance & Real Estate	2,346	5.8	2,261	5.3	3,124	6.0	33.16
Services	7,906	19.5	8,086	19.3	10,596	20.5	34.02
Government	7,669	18.5	7,928	18.9	8,262	16.0	7.73
Other	130	0.3	(209.4)[2]	(0.5)[2]	(155.2)[2]	(0.3)[2]	19.23
Total	40,597	100.0	41,883	100.0	51,755	100.0	27.48

Source: **Bureau of Business and Economic Research,** Regional Measurement Division, Regional Economic Information System, "Employment by Type", 1978.

(L) Less than 10 wage and salary jobs.
* Not all proprietors work their own farms.
[1]Confidential data, estimated from 1972 figures.
[2]Confidential data, estimated from 1971-1977 figures.

Table F-6
Richland County, North Dakota,
Employment by Industry
(Full & Part-Time)

INDUSTRY	1971 NUMBER	1971 % TOTAL	1972 NUMBER	1972 % TOTAL	1977 NUMBER	1977 % TOTAL	PERCENT CHANGE 71-77
Agriculture (total)	2099	29.7	2045	23.9	1941	23.4	-7.52
Proprietors*	1765	25.0	1708	24.1	1577	19.0	-10.65
Wage and Salary Employment	334	4.7	337	4.8	364	4.4	8.98
Non-agriculture (total)	4959	70.3	5039	71.1	6363	76.6	28.31
Proprietors	597	8.5	560	7.9	618	7.4	3.52
Wage and Salary Employment	4362	61.8	4479	63.2	5745	69.2	31.71
Construction	(183.5)[2]	(2.6)[2]	(184.2)[2]	(2.6)[2]	361	4.3	96.20
Manufacturing	238	3.4	283	4.0	824	9.9	246.22
Transportation & Utilities	276	3.9	270	3.8	263	3.2	-4.71
Wholesale & Retail Trade	1094	15.5	1051	14.8	1337	16.1	22.21
Finance, Insurance & Real Estate	117	1.7	129	1.8	158	1.9	35.04
Services	727	10.3	731	10.3	843	10.2	15.96
Government	1703	24.1	1754	24.8	1867	22.5	9.63
Other	20	0.3	(21.3)[2]	(0.3)[2]	(91.3)[2]	(1.1)[2]	360.00
Total	7058	100.0	7084	100.0	8304	100.0	17.65

Source: Bureau of Business and Economic Research, Regional Measurement Division, Regional Economic Information System, "Employment by Type", 1978.

(L) Less than 10 wage and salary jobs.
* Not all proprietors work their own farms.
[1]Confidential data, estimated from 1972 figures.
[2]Confidential data, estimated from 1971-1977 figures.

Table F-7
Barnes County, North Dakota,
Employment by Industry
(Full & Part-Time)

INDUSTRY	1971 NUMBER	1971 % TOTAL	1972 NUMBER	1972 % TOTAL	1977 NUMBER	1977 % TOTAL	PERCENT CHANGE 71-77
Agriculture (total)	1682	27.8	1631	27.0	1542	23.7	-8.32
Proprietors*	1445	23.9	1417	23.5	1346	20.7	-6.85
Wage and Salary Employment	237	3.9	214	3.5	196	3.0	-17.29
Non-agriculture (total)	4376	72.2	4408	73.0	4955	76.3	13.23
Proprietors	522	8.6	503	8.3	514	7.9	-1.53
Wage and Salary Employment	3854	63.6	3905	64.7	4441	68.4	15.23
Construction	189	3.1	198	3.3	305	4.7	61.37
Manufacturing	(90)[1]	(1.5)[1]	88	1.5	157	2.4	74.44
Transportation & Utilities	209	3.4	213	3.5	147	2.3	-29.67
Wholesale & Retail Trade	1128	18.6	1108	18.3	1395	21.5	23.67
Finance, Insurance & Real Estate	132	2.1	147	2.4	138	2.1	4.55
Services	(799.6)[1]	(13.2)[1]	795	13.2	948	14.6	21.54
Government	1326	21.9	1347	22.3	1329	20.5	0.23
Other	6	0.1	9	0.1	(12.9)[2]	(0.2)[2]	115.00
Total	6058	100.0	6039	100.0	6497	100.0	7.25

Source: Bureau of Business and Economic Research, Regional Measurement Division, Regional Economic Information System, "Employment by Type", 1978.

(L) Less than 10 wage and salary jobs.
* Not all proprietors work their own farms.
[1] [illegible] data, estimated from 1972 figures.
[2] [illegible] data, estimated from 1971-1977 figures.

Table 8
Employment by Industry
Ransom County, North Dakota
(Full & Part-Time)

INDUSTRY	1971 NUMBER	1971 % TOTAL	1972 NUMBER	1972 % TOTAL	1977 NUMBER	1977 % TOTAL	PERCENT CHANGE 71-77
Agriculture (total)	941	34.0	891	31.5	798	26.0	-15.20
Proprietors*	809	29.2	769	27.2	681	22.2	-15.82
Wage and Salary Employment	132	4.8	122	4.3	117	3.8	-11.36
Non-agriculture (total)	1830	66.0	1940	68.5	2267	74.0	23.88
Proprietors	299	10.8	273	9.6	298	9.7	-0.33
Wage and Salary Employment	1531	55.3	1667	58.9	1969	64.2	28.61
Construction	34	1.2	59	2.1	75	2.4	120.59
Manufacturing	117	4.2	171	6.0	244	8.0	108.55
Transportation & Utilities	157	5.7	154	5.4	157	5.1	0.00
Wholesale & Retail Trade	483	17.4	463	16.4	552	18.0	14.29
Finance, Insurance & Real Estate	51	1.8	66	2.3	71	2.3	39.22
Services	167	6.0	226	8.0	307	10.0	83.83
Government	516	18.6	516	18.2	548	17.9	6.20
Other	6	0.2	(L)	-	14	0.5	133.3
Total	2771	100.0	2831	100.0	3065	100.0	10.60

Source: Bureau of Business and Economic Research, Regional Measurement Division, Regional Economic Information System, "Employment by Type", 1978.

(L) Less than 10 wage and salary jobs.
* Not all proprietors work their own farms.
[1]Confidential data, estimated from 1972 figures.
[2]Confidential data, estimated from 1971-1977 figures.

in wholesale-retail trade, services, and government increased. (See tables F-5 to F-8 for a breakdown of employment by industry.)

Agriculture

Agriculture employed the largest percentage of the total work force in 1977 (including both paid laborers and proprietors) in Barnes, Ransom, and Richland Counties, accounting for 23.7, 26.0, and 23.4 percent of their respective county's labor force. A highly urban area, Cass County employed only 4.1 percent of the total work force in agriculture. Despite the large number of agriculture employees, all four counties have experienced significant decreases in agricultural employment from 1971 to 1977. The greatest decline occurred in Ransom County (15.2 percent), while Richland County experienced the smallest decrease (7.52 percent).

Wholesale-Retail Trade

Wholesale-retail trade increased in all four counties from 1971 to 1977. In Barnes and Cass Counties (1977), wholesale-retail trade represented the largest employer of the labor force (not including proprietors), with 21.5 and 28.5 percent of the total employed, respectively.

The greatest increase in wholesale-retail trade employment from 1971 to 1977 occurred in Cass County (41.84 percent), while the smallest increase occurred in Ransom County (14.29 percent).[1]

Services

The number of persons employed in services (cleaning, food, personal, or protective (excluding private households)) increased from 1971 to 1977 in the four counties. The largest increase in services occurred from 1971 to 1977 in Ransom

(1) Although data for 1971 are not available for Richland County, data for 1972 through 1977 indicated an increase.

County (83.83 percent) with the smallest increase in Richland County (15.96 percent). Cass County employed the largest proportion of its total labor force in services (20.5 percent), while in Ransom County, services employed the smallest proportion (10.0 percent).

Government

Government employment refers to all Federal, State, and local employees and those persons employed in government-funded businesses; e.g., post office or water treatment facilities. Government-related jobs have increased in all four counties from 1971 to 1977, with the largest percentage increase occurring in Richland County (9.63 percent). The smallest percentage increase occurred in Barnes County (0.23 percent). Government employed the largest percentage of total population in Richland County (22.5 percent) and the smallest percentage in Cass County (16.0 percent).

Summary

Overall, employment in nonagricultural industry, such as wholesale-retail trade, services, and government, exceeds agricultural employment. This is true even though the four-county area has traditionally been rural in character. The decline in agricultural employment has been consistent over the last three decades. This decline may be attributed in part to more effective capital-intensive farming corporations which displace the smaller labor-intensive farms. Also, the out-migration of young adults to urban areas for better economic opportunities leaves fewer people available to take over the family farm.

PER CAPITA INCOME

Per capita income (PCI) is an approximate measure of the income available for consumption at any one time. While the exact figures have little importance, their magnitude in relation to State and national figures is an indicator of the

relative wealth of the area. Another important aspect of the per capita income statistic is how it changes over time when converted to constant dollars. It can then represent the change in the relative buying power of consumers over time, and the probable accumulation of damageable property. Table F-9 shows the average of Series E and Series C per capita income statistics for the United States, North Dakota, the Fargo-Moorhead BEA area, and the Grand Forks-East Grand Forks BEA area.

North Dakota per capita income has fluctuated between 78 and 88 percent of the U.S. per capita income. This is not unexpected in a State which depends heavily on agriculture. Incomes for North Dakota are projected to stay within the same historical percentage range. The per capita income for the Fargo-Moorhead BEA area has been and is projected to be slightly lower than the State per capita income, while the Grand Forks area per capita income should be higher. The index of change in per capita income for the Fargo-Moorhead and Grand Forks BEA areas is shown in table F-9.

PRESENT LAND USE

Introduction

The Sheyenne River basin can be divided into five major units of land use: cropland, pasture or rangeland, wetlands, urban, and woodland.

Table F-10 for the Sheyenne River basin is taken from a draft report entitled "Land Use, Assessment, and Needs - Non Point Source Task Force," North Dakota State Soil Conservation Service Committee. The report was prepared in conjunction with the North Dakota Statewide 208 Water Quality Plan and represents the land use as of 1 January 1977.

Table F-9 Historical and projected per capita income for Fargo (constant 1967 dollars)

Economic area	1950	1962	1970	1980	1990	2000	2010	2020	2030 (2)	2040 (2)
United States average Series "E" and "C"	2,065	2,584	3,476	4,733	6,133	8,195	10,673	13,730	17,050	19,800
North Dakota average Series "C" and "E"	1,745	2,345	2,717	3,892	5,156	7,024	9,400	12,164	15,150	17,700
Fargo-Moorhead average Series "C" and "E"	1,657	2,174	2,624	3,692	4,951	6,767	9,132	11,869	14,605	17,200
As a percent of North Dakota	95	93	97	95	96	96	97	98	96	97
Index of Change Fargo-Moorhead					1.000	1.367	1.844	2.397	2.950	3.474

1 Not published. Estimated in 1970, taken from Series E.

2 Estimated from best fit curve.

Source: U.S. Bureau of Economic Analysis, U.S. Department of Commerce.

Table F-10 Land use in the Sheyenne River basin

Land use	Acres	Percent
Cropland	2,400,000	71
Pasture or rangeland	650,000	19
Wetland	150,000	5
Urban	92,000	3
Large water	40,000	1
Woodland	38,000	1

Source: ND State Soil Conservation Service Committee, "Land Use Assessment, and Needs - Non Point Source Task Force"

Prime and Unique Farmlands

A national inventory of prime and unique farmland has been conducted in North Dakota by the Soil Conservation Service. Prime farmland is land best suited for producing food, feed, forage, fiber, and oilseed crops. If not used for these already, it must at least be available for these uses; the land could be cropland, pastureland, rangeland, forest land, or other. It cannot be urban builtup or water (wetland). It has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops. This production should be economically possible when the land is treated and managed (including water management) according to modern farming methods (see plates D-6 through D-9 for prime farmlands).

Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. No unique farmland is in the Sheyenne River basin

Nonurban Land Use

There are two distinct farming types in the floodplain area. The upper reaches (1-4) have a great deal of pasture and hayland, generally indicative of

a mixed crop and livestock farming operation. Reaches in the bed of glacial Lake Agassiz are almost exclusively cash cropping areas. Only 5 percent of the land is in other uses. In these lower reaches, thousands of highly productive, almost flat, agricultural acres are intensively cultivated.

Reach 5 represents a transition between the two farming types. Although primarily a cash crop area, Reach 5 includes some livestock-support crops - hay, corn, and soybeans. Many of the farmers raise livestock but very few depend on it exclusively. Table F-11 summarizes the nonurban land use in the floodplain. As cropland, the floodplain is very productive. The principal crops include wheat, barley, sunflowers, corn, and soybeans.

Crop-yield data (table F-12) were obtained from county representatives of the U.S. Department of Agriculture and local farmers. These yields are slightly higher than the county averages because the floodplains often contain more productive soils.

Urban Land Use

There are two types of urbanized areas in the Sheyenne River floodplain: the towns and unincorporated urban areas containing mixed land uses, and the somewha smaller subdivisions containing primarily residential land. A plate provided by the Lake Agassiz Regional Council has been expanded and updated using aerial photography. It shows the urbanized development from Kindred to the mouth of the river. Incorporated cities are shown in black and residential subdivisions in red. (See the "Urban Areas, Rural Developments, and Homesteads" plate at the end of this appendix.)

Within the cities there are a number of land uses. Tables F-13 through F-15 show the intercity land uses for West Fargo, Valley City, and Riverside. Land use maps of Lisbon are not available. The following tables summarize the land use in each category for each of these cities. Land-use plates for West Fargo, Valley City, and Riverside (1977 conditions) are at the end of this appendix.

Table F-11 Nonurban land use (in percent)(1977 conditions)

Crop[1]	Reach								
	1	2	3	4	5A	5B	5C	5D	5E
Wheat	17.9	8.7	12.5	10.0	45.0	45.0	52.0	57.0	54.0
Barley	5.8	5.9	5.0	5.0	27.0	30.0	28.0	23.0	13.0
Soybeans	-	-	-	-	13.0	-	3.0	9.0	15.0
Sunflowers	3.0	-	-	-	7.0	7.0	9.0	7.0	15.0
Hay	4.8	4.0	22.0	22.0	-	4.0	-	-	-
Flaxseed	3.0	3.3	2.8	2.8	-	-	-	-	-
Sugar beets	-	-	-	-	-	-	-	-	-
Potatoes	-	-	-	-	-	-	-	-	-
Oats	-	3.3	9.3	9.3	-	-	-	-	-
Corn	0.5	1.3	5.4	5.4	3.0	6.0	3.0	-	-
Pasture	30.0	33.0	14.0	14.0	-	-	-	-	-
Fallow	5.0	7.5	5.0	7.5	-	-	-	-	-
Other	30.0	33.0	24.0	24.0	5.0	8.0	5.0	4.0	3.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

(1) These crops constitute the major crops grown in the area. No other single crop has more than 4 percent of the land use.

Table F-12 Crop yields per acre[1]

Crop	Reach 1	2	3	4	5A	5B	5C	5D	5E
Wheat	35.0 Bu.	29.0 Bu.	32.5 Bu.	30.0 Bu.	35.0 Bu.	37.0 Bu.	39.0 Bu.	40.0 Bu.	40.0 Bu.
Barley	45.0 Bu.	37.0 Bu.	42.0 Bu.	44.0 Bu.	45.0 Bu.	47.5 Bu.	52.0 Bu.	55.0 Bu.	55.0 Bu.
Soybeans	-	-	-	-	18.5 Bu.	-	18.0 Bu.	18.0 Bu.	20.0 Bu.
Sunflowers	15.0 CWT	-	-	-	13.0 CWT	13.0 CWT	13.3 CWT	13.5 CWT	14.0 CWT
Hay	1.7 TONS	2.0 TONS	1.9 TONS	2.0 TONS	-	3.8 TONS	-	-	-
Flaxseed	15.0 Bu.	11.0 Bu.	14.5 Bu.	14.0 Bu.	-	-	-	-	-
Sugar beets	-	-	-	-	-	-	-	-	-
Potatoes	-	-	-	-	-	-	-	-	-
Oats	-	44.0 Bu.	53.0 Bu.	52.0 Bu.	-	-	-	-	-
Corn	9.0 TONS	6.6 TONS	10.3 TONS	12.6 TONS	11.0 TONS	11.0 TONS	11.0 TONS	-	-
Pasture	2.0 TONS	2.0 TONS	2.0 TONS	2.0 TONS	-	-	-	-	-

(1) Information locally obtained.

Table F-13 Planimetered land use - West Fargo and Cass County area west to I-94(1) (1977 conditions and 1980 revisions).

Land Use Category	Acres	Percent of Total	Percent of Total Developed Area	Revised to 1980 conditions[2]	Percent of Total 1980	Percent of Total Developed Area 1980
Single-family	373	12.9	27.4	444	13.7	24.4
Multiple-family	139	4.8	10.2	200	6.2	10.8
Commercial - industrial	439	15.2	32.2	302[3]	9.3	16.3
Parks-public institutions	150	5.2	11.2	643[3][4]	19.9	34.8
Vacant and platted	366	12.7	-	295	9.1	-
Vacant and not platted	1163	40.2	-	1095	33.8	-
Streets and alleys	260	9.0	19.0	260	8.0	14.1
Total	2890	100.0	100.0	3239	100.0	100.0

(1) Planimetered land includes city and nonagricultural land west to I-94; no planimetering was done on agricultural land in the area.

(2) Some of these changes represent changes in zoning plus revisions to previously reported information.

(3) Bonanzaville and the county fairgrounds were formerly listed as commercial. The city of West Fargo has indicated that a public designation would be more appropriate.

(4) Includes newly acquired sewage treatment lagoons.

Table F-14 Planimetered land use - Valley City
(1977 conditions and 1980 revision)

Land use category	Acres	Percent of total	Percent of total developed area	Revisions	Percent of total 1980	Percent of total developed area 1980
Single-family	378	28.5	42.4	424	29.3	40.3
Multiple-family	59	4.4	6.6	97	6.7	9.2
Commercial/industrial	171	12.9	19.1	249	17.2	23.7
Parks-public institutions	285	21.5	31.9	282	19.5	26.8
Vacant and platted	130	9.8	-	167	11.5	-
Vacant and not platted	304	22.9	-	228	15.8	-
Total	1327	100	100	1447	100	100

Source: Planimetered from land use maps by the Corps of Engineers

Table F-15 Land use at Riverside, North Dakota (1977 conditions)

Land use	Number of Acres Zoned	1980 Number of Acres Zoned
Single-Family	68	62
Multiple-family & mobile homes	33	33
Commercial-industrial	360	365
Parks	11	12
Agriculture	9	31
Total	481	503

Source: Planimetered from land use maps by the Corps of Engineers.

West Fargo and Riverside have shown extensive residential growth. In West Fargo, residential growth is occurring in the floodplain on the west side of the Sheyenne River and at higher elevations on the east side of the city. Residential structures in the floodplain on the west bank of the Sheyenne River are being elevated. In Riverside, residential growth is occurring at higher elevations in the floodplain on both sides of the Sheyenne River. Potential residential damages in the West Fargo—Riverside area more than quadrupled since the 1968 interim survey report. The number of single-family homes has doubled, and many multiple-family dwellings have been constructed in the floodplain. Also, the values of most of the houses have increased significantly. Many new commercial and public structures have also been constructed in or adjacent to West Fargo-Riverside during this period.

Harwood is approximately 8 miles from Fargo. In recent years, Harwood has experienced an increase of residential development by people who perhaps work in Fargo but who prefer the amenities of small town living. Table F-16 gives the percentage of land use at Harwood in each category.

Table F-16

Existing land use at Harwood, North Dakota

Category	As percent of Developed Land	As percent of Total Land
Developed Land		
Residential	65.6	7.0
Commercial - Industrial	29.8	3.2
Public	4.6	.5
Vacant Land	-	89.3
Totals	100.0	100.0

Source: Planimetered from land use maps by the Corps of Engineers.

(R 3/83)

CHANGES IN LAND USE SINCE 1977

Agricultural Land Use

An existing condition agricultural evaluation may be considered a "snapshot" in time of the agricultural capability of the area. The land use of the study area in 1977 reflected the best economic capabilities of the land in terms of maximized net return. The upstream areas were basically mixed livestock and livestock support with some cropping. Downstream Reach 5 was basically a crop reach with emphasis on small grains.

Since 1977, total lands devoted to each generalized agricultural use (crop, pasture, farmstead, etc.) have not changed significantly. As in many agricultural areas, however, the distribution of crops in this area is constantly in a state of change because of market conditions. For example, the study area now has significant acres of sunflowers, a crop practically unknown there prior to 1975. Reach 5 also has increased acreages of edible beans, but somewhat fewer acres of wheat, barley, and oats.

Relative changes in market prices could shift specific crop production mix in any of several directions, but the generalized uses (see above) are not expected to change drastically unless major, unforeseen technological or other external factors change.

Agricultural Yields

Yields of the traditional small grain and livestock feed crops have shown minor increases between 1977 and 1980. Yields for new crops (sunflowers and edible beans) have risen steadily as more of the farmers acquire greater experience and education in managing the crop. Such changes will not be reflected in the existing condition agricultural analysis.

Urban Land Use

Rural Subdivisions - Although these areas have grown since 1977, most of the growth took place in 1978. Floodplain units built during this time comply with the generalized flood insurance requirements. Table F-17 shows the building permits issued by Reed and Barnes Townships, the two townships adjacent to West Fargo. Similar growth is expected in Stanley Township.

Table F-17
Building permits issued since 1977: Reed and Barnes Townships

Township	Year		
	1978	1979	1980
Reed Township	30	3	3
Barnes Township	17(1)	13	8

(1) Includes commercial permits

Source: Township clerks.

West Fargo - Table F-18 shows 1980 land use in West Fargo. The only annexation West Fargo has made since 1978 has been the 349 acres for the sewage treatment lagoons. Other changes in land use have resulted from land being developed that previously had been vacant. Changes in the number of structures as reflected by building permits are shown below.

Table F-18
Building permits: West Fargo

Type of Structure	Year			
	1978	1979	1980	Total
Single-Family	322 units	53	38	553 units
Multifamily or duplexes		14 (70 units)	17(70 units)	
Commercial(1)	11	53	35	99 permits

(1) Includes signs

Source: West Fargo City Engineer

An additional 553 residential units have been added since 1977. Because the classification system included signs with other commercial permits, the change in commercial units is unknown. All units conform to floodplain regulations.

Valley City - The most significant growth with Valley City's urban area occurred in commercial-industrial and multiple-housing development areas. The recorded growth in commercial-industrial and multiple-housing can be attributed to the annexation of 107 acres, rather than a change in previously zoned land use. No significant change has taken place in the floodplain areas.

Riverside - Since the original survey, 6.3 percent of Riverside has been developed. The most significant increase was commercially-zoned land, with 4.9 percent developed since 1977, including the Cargill plant. The city of Riverside has reclassified 5 acres of land zoned for single-family residences to commerically-zoned. Riverside has recently annexed 22 acres to the city. Although this newly-annexed area is currently zoned agricultural, the city plans to eventually rezone this land as commercial so that a sewage plant can be built on the site. The city also rezoned 1 acre of land zoned for single families to parkland. Development complies with floodplain zoning ordinances.

FUTURE LAND USE

Introduction

Land use changes in this report are based on projected population changes. OBERS uses changes in the national population to represent changes in demand for agricultural products. Thus, an increase in population implies increased demand for and production of agricultural commodities. The OBERS agricultural projections are discussed under the agricultural portion of this section. Local population

projections also reflect the potential demand for new nonagricultural land uses. Residential, commercial, and public development are precipitated by increased demand in the form of population. Industrial development depends more on the basic resources available in the area and the accessibility of a market. As a population in the study area grows, a larger local market for goods develops, enhancing area attractiveness for industry.

The Fargo-Moorhead Metropolitan Council of Governments (F-M COG) has projected land use changes to the year 2000, based on a projected population of 157,000 for the SMSA, only slightly less than the 166,000 persons estimated in this report. Because of the similarity in the population projections, the F-M COG's land use projections form the basis for the urban analysis.

Agricultural

Table F-20 summarizes the agricultural land use in the lower Sheyenne River basin and the State of North Dakota for the last two agricultural censuses. The lower basin has been divided into two areas consistent with the type of farming described in the existing land use section. Cass County forms one area and Barnes, Ransom, and Richland Counties form the other.

Table F-19 Summary of Land Use

Item	Total land area (in 1,000 acres)	Percent of total land area used for agriculture(2) 1969	1974	1978(3) Preliminary
Farmland				
Cass County	1,119.4	98.7	93.0	99.9
Other Counties (1)	2,425	98.2	98.4	99.2
North Dakota	44,339.2	97.2	95.6	94.8
Cropland				
Cass County	1,119.4	91.4	85.2	91.3
Other Counties (1)	2,425	81.3	80.9	81.2
North Dakota	44,339.2	66.4	65.8	65.2
Forest				
Cass County	1,119.4	1.0	0.8	0.8
Other Countries (1)	2,425	1.4	1.0	1.1
North Dakota	44,339.2	1.0	1.1	1.0
Other Uses				
Cass County	1,119.4	6.3	7.0	4.1
Other Countries (1)	2,425	15.5	16.4	12.4
North Dakota	44,339.2	29.8	28.6	24.5

(1) Barnes, Ransom, and Richland Countries
(2) U.S. Census of Agriculture
(3) 1978 preliminary figures are included for informational purposes only. Because of the percentages and direction of change which is contrary to observed actions, final county numbers are expected to be revised.

In 1969, approximately 98 percent of the total land in each area was in farms. By 1974, almost 6 percent of the land in Cass County had changed to nonfarm uses. Farmland in the other counties remained about the same. The land in Cass County that changed to nonagricultural uses appears to be cropland, which also suffered a 6-percent decline during this period. For the State, land in farms has decreased by 1.5 percent during the same time period, with the largest loss occurring in the "other uses" category. The OBERS Bureau of Economic Analysis projects that approximately 94.3 and 94.1 percent of North Dakota's land area will be in farms in the years 2000 and 2020, respectively. The historic statewide stability of farmland is expected to continue with significant conversion to other uses only in areas subject to more urbanization and mining pressure. In the study area, the only substantial conversions to other uses are projected in the Fargo-West Fargo area.

Most urban development in Cass County has taken place along the Sheyenne River and between the Sheyenne and Red Rivers. This area contains approximately 166 sections that could possibly be diverted from farmland to urban uses, but projected population increases do not indicate development this extensive. It is estimated that at least 83.5 percent of Cass County will still be in farms by 2035. In the rest of the county, very little conversion of farmland would be expected because of only minor increases or declines in projected populations. Where and when these changes will occur are discussed in the following pages.

Urban

In the report "Metropolitan Land Use Element," the F-M COG has projected acreages needed in various categories to satisfy the demands of their projected 1990 and 2000 populations. Although population is not the only determinant of land use, it is the most projectable and reliable.

The F-M COG projects a population of 157,000 for the Fargo-Moorhead SMSA by the year 2000. By comparison, the method discussed on page F-11 (table F-6) indicates a population of 166,000. The area most likely to have major shifts in land use is that immediately adjacent to the Fargo-Moorhead metropolitan area (to use F-M COG definition, the land adjacent to the "urban core"). The urban core consists of Reed and Barnes Townships in North Dakota, Oakport and Moorhead Townships in Minnesota, and the urbanized areas that they surround. This area covers approximately 24,500 developed acres and 63,800 vacant acres. F-M COG has projected that the four major cities which the urban core comprises - Fargo, West Fargo, Moorhead, and Dilworth - and their adjacent areas will continue as an increasing percentage of the SMSA. By the year 2000, these core cities are expected to account for 85 percent of the SMSA's total population (p. 41, Metropolitan Land Use Element - F-M COG, August 1978) or 133,450 people. Since F-M COG's report was prepared, the 1980 preliminary census figures have been released: these figures show a slightly slower growth rate than that projected for the four cities, probably because of the expansion in the rural subdivisions. The number of persons

projected in 2000 for the urban core, however, is compatible with the population in table F-1. F-M COG's projection of land use will be used for this analysis. F-M COG's projection assumes that historic rates of development will continue in urban and nonurban portions of the urban core. Although this may temporarily underestimate the rural subdivisions, it is probable that those located adjacent to cities will request annexation. Table F-20 is a partial reproduction of a projected land needs table from the F-M COG land use report. This table provides a base from which to project future land use.

Table F-20 Projected land needs in Fargo-Moorhead urban core

Land use classification	Projected additional acres developed in the urban core by the year 1990	2000
Single-family residential	700	1,190
Multifamily residential	116	197
Industrial	97	164
Transportation, communication, and utilities	1,257	2,136
Commercial	249	424
Public/semipublic	206	350
Parks and recreation	245	417
Total developed land	2,870	4,878

Source: Fargo-Moorhead Council of Government, Metropolitan Land Use Elements, 1978.

Page 44 of the F-M COG report states that if future proportions of land in each classification remain similar to today's, 1,400 acres of land, instead of shifting toward multifamily use, will be needed for both single-family and multifamily homes. In its reports on the "Metropolitan Housing Element," the F-M COG estimates

that with the declining household size an additional 9,336 and 4,884 dwelling units will be needed between 1980 and 2000 in Cass and Clay Counties (note: not the urban core), respectively.

The preceding paragraph gives an overview of the type and amount of development expected to occur in the urban core area. The location of these future developments will depend greatly on past trends and current land use policies as they apply to each of the land use categories. For purpose of analysis, only three basic land use categories will be dealt with in any depth: industrial, commercial, and residential. (These three categories tend to determine the location of other development.) This analysis relies on a series of steps:

1. Past land use will be analyzed in terms of the general qualities traditionally sought by these three categories.

2. Those qualities which make the communities in the study area either attractive or not attractive to a particular use will be enumerated.

3. The land use projection that will be used in this report to represent the most probable future without project condition (in light of current policies) will be defined.

4. Some of the factors which make accurate land use projections difficult will be described.

To begin the analysis, projected land use in the Fargo-Moorhead SMSA must be apportioned to each State. Table F-21 shows the percentage of land in each geographic area for each land use category. If other factors, such as tax and development policies, remain equal, land developed in the future should retain the same split between States and areas. This has not been true since the construction of West Acres, but there has not been sufficient time to evaluate any trends which might indicate the permanence of the impact. The expected geographic breakdown of demand for the year 2000 was derived by multiplying the existing land use percentages by the population index of change for the area and redistributing the land use as percentages. Table F-21 shows the percent distribution of land uses among categories.

Table F-21 - Land use by State in the Fargo-Moorhead SMSA urban core as a percentage of the urban core

Land use classification	1976 percentage of land use by State and area: North Dakota: Cities	North Dakota: Fringe area	Sub-total	Minnesota: Cities	Minnesota: Fringe area	Sub-total	Total percent of 1976 land use	Total urban core (1976)
Single-family residential	39	28	67	20	13	33	100	6,555
Multifamily residential	77	0	77	23	0	23	100	636
Industrial	33	23	56	4	40	44	100	1,442
Transportation, communications and utilities	45	23	68	17	15	32	100	11,177
Commercial	68	14	82	14	4	18	100	1,681
Public/semipublic	71	14	85	13	2	15	100	1,362
Parks and recreation	56	12	68	25	7	32	100	1,676
Total developed land	47	22	69	17	14	31	100	24.529

(1) Derived from Table 7 in F-MCOG's "Metropolitan Land Use Element."

(R 3/83)

Table F-22 shows the locational breakdown of the projected land use needs for the North Dakota side of the SMSA. This was derived by multiplying the projected acreages from table F-20 times the projected percentage breakdowns on table F-21.

Table F-22 - Projected additional acres of land needed for future development in the North Dakota portion of the Fargo-Moorhead urban core(1)

Category	Year 1900 (2) Cities Acres	Year 1900 (2) Fringe areas Acres	Year 2000 Cities Acres	Year 2000 Fringe areas Acres
Single-family residential	273	196	464	333
Multifamily residential	89	-	152	-
Industrial	32	22	54	38
Transportation, communication and utilities	566	289	961	491
Commercial	169	35	288	59
Public/semipublic	146	29	248	49
Parks and recreation	137	29	233	50
Total developed land	1,412	600	2,400	1,020

(1) Based on acres from table F-20 and percentages from table F-21.
(2) Same percent as current.

Table F-23 shows the total projected land use in the North Dakota urban core for 1977, 1990, and 2000.

Table F-23 - North Dakota land use in the Fargo-Moorhead urban core by acres(1)

Land use classification	1977 Cities	1977 Fringe area	1990 Cities	1990 Fringe area	2000 Cities	2000 Fringe area
Single-family residential	2,546	1,828	2,819	2,024	3,010	2,161
Multifamily residential	491	-	580	-	643	-
Industrial	479	337	511	359	533	375
Transportation, communication and utilities	5,088	2,588	5,654	2,877	6,049	3,079
Commercial	1,146	243	1,315	278	1,434	302
Public/semipublic	969	189	1,115	218	1,217	238
Parks and recreation	934	208	1,071	237	1,167	258
Total developed land	11,653	5,393	13,065	5,993	14,051	6,413
Vacant land	3,851	27,123	2,439	26,523	1,453	26,103
Total land	15,504	32,516	15,504	32,516	15,504	32,516

(1) Derived by adding the acres from table F-22 to the totals from table F-21.

(R 3/83)

Criteria for Building Site Selection

After an industry has decided to locate in a specific area, selection of a particular building site depends on a number of key factors:

a. Availability of a suitably sized site.

b. Appropriate zoning or prospect of change to appropriate zoning.

c. Municipal services such as water supply, waste disposal, and fire and police protection.

d. Ease of access to major transportation activities.

e. Proximity to suppliers or consumers.

f. Receptivity of local government and possible incentives offered to industry.

Most industry in the study area has located in industrial parks or subdivisions along or directly behind commercial development on Highways 10 and 52 or in the fringe areas outside of Riverside. Industries located in the fringe areas include the Union Stockyards and grain terminals. These particular industries are generally incompatible with urban development.

Commercial developers generally look for the following site characteristics:

a. Good access from major thoroughfares.

b. A large traffic flow past the site.

c. The proximity of other commercial establishments.

d. Land availability.

e. Ability of local governments to provide needed services.

Commercial development in the study area has taken place in Fargo's central business district and along Highway 81 (University Avenue), North Broadway, North Dakota Highways 10 and 52, and Interstate 29. Commercial

development in West Fargo is along Highways 10 and 52 and Sheyenne Street. Very little commercial development has taken place outside of either city's limits.

The selection criteria for residential location are slightly different. Residential development seems to accumulate in the most aesthetically pleasing land or on land not needed for other types of development. Personal selection of a home depends on a variety of economic and social factors. The following factors probably affect individual home selection in the study area:

a. Availability at a specific price.

b. Cost and availability of financing.

c. Yearly taxes, average maintenance, and upkeep.

d. Population density.

e. Social class and income.

f. Distance from employment.

g. School quality.

h. Adjoining land uses.

i. Rural-urban subcultural distinction.

j. Age-dependency factors.

Most new residential development in the study area has been done by large-scale developers in the urban areas. The greatest factor determining where this growth will occur has been the availability of land. Most residential growth has taken place adjacent to the cities, along I-29, and along the Sheyenne and Red Rivers.

Policies Affecting Future Land Use

Four major policy questions affect the location of future development in the Fargo-West Fargo area: annexation, extraterritorial zoning, flood insurance or floodplain development, and prime farmland conversion. Municipalities in North Dakota may annex areas adjacent to their boundaries to simplify area government or to join areas which are economically interdependent. Annexation may also be used to encourage ordered development. In general, most annexation in the area has taken place at the request of the affected property owners. A common practice is for a developer to request annexation, a change of zoning, and platting all at the same time. Until this happens, most land adjacent to cities is zoned agricultural. All municipal and township governments in the study area retain a great deal of flexibility in their zoning and are receptive to requests for change.

Fargo and West Fargo/Riverside have anticipated annexation as part of their capital improvements expansion plan. Fargo has planned for the availability of additional municipal services in the recently annexed southwest portion of the city. Areas suitable for future development are available to the south and west of the city, although in 1978 Fargo had no immediate plans for further annexations. The West Fargo/Riverside area is planning wastewater facilities to serve an area from the current eastern municipal boundary south to I-94, along I-94 to the intersection with Highways 10 and 52, one-half mile north from this intersection near Seventh Avenue North, then eastward along Seventh Avenue North to a northward extension of the current eastern municipal boundary. Extension of services into this area suggests the probability of annexation of some of these lands. Harwood, which incorporated and annexed approximately 40 acres in 1978, is preparing a land use plan and zoning map. Riele's Acres anti-

cipates no future annexations (an additional 40 acres was added in 1978, bringing the total area to about 120 acres). Both Reed and Barnes Townships recognize the inevitability of losing some land by annexation.

North Dakota municipalities have the authority to zone outside their corporate limits to encourage orderly growth and development, recognizing the possibility of future annexations. This authority supersedes the zoning authority of township and local governments. In the study area, Fargo has a 2-mile extraterritorial zoning authority, West Fargo a 1-mile authority, and all other municipalities a half-mile extraterritorial authority. Where there is a conflict in extraterritorial authority, a compromise line has been drawn. In general, extraterritorial zoning has not been used aggressively to regulate development. Land outside the municipal boundaries is zoned for its existing use, which is primarily agricultural.

To develop property in this *extraterritorial zoning area*, the individual or organization desiring a change in zoning must get that area rezoned by the municipality and then obtain a building permit from the township. Since most of the conversions have been from agricultural to residential land, the major question in changing zoning has been the adequacy of the proposed wastewater treatment facilities and the probability of future extension of municipal services. To be approved, all developments, except those for which municipal facilities are planned for development by 2000, must have long-term self-sufficient sewer, wastewater, and water systems. The extraterritorial zoning power is being used to avoid the evident future problems that necessitate municipal expansion.

The flood of 1897 inundated the entire study area except for all or part of sections 23-26, 34, 35, and 36 in Reed Township. The flood insurance study for Reed Township indicates that all of this area is subject to inundation but shows

parts of sections 18, 19, and spots in sections 8, 17, and 20 as Flood Hazard Zone C areas subject to minimal flooding. The largest areas in Zone C are for the most part not developed. All other areas in the township are in a flood hazard area.

Flood-free land will become available at the discretion of landowners. Sections 1, 2, 12-15, 22, 23, and 24 in Barnes Township and less than half of sections 10, 11, and 25-28 were not inundated by the 1897 flood. Flood insurance maps are not available for this area. Approximately two-thirds of the flood-free land in Barnes Township is developed, leaving very little flood-free land available for development.

Vacant land in other areas is also not viewed as having very serious flood problems. Because of public emergency works, private levees, flood magnitude, upstream breakouts, and backwater differences, the recent floods of 1969, 1975 (summer), 1978, and 1979 have inundated primarily the area downstream and to the west of West Fargo. These floods have ranged in magnitude from a 5-percent frequency flow in 1969 and 1975 to a 4-percent frequency flow in 1979 - all fairly large events. Because of the success of past fights against these large floods, many units in the floodplain have not been inundated, making the probability of flooding seem fairly remote. Consequently, most land in the area is seen as having some sort of a flood problem, but only for extremely large floods.

All communities and townships in the study area have adopted and now enforce some type of floodplain regulation. However, Fargo, West Fargo, Harwood, Reed Township, and Riverside are the only communities having floodplain information reports available as well. All of Harwood, about 80 percent of Riverside, and most of West Fargo and Reed Townships except

for the exemptions discussed above, are in Flood Hazard Zone A. A unique feature of these ordinances is a basement exemption which allows structures in the flood-hazard area to have basements, provided that they are substantially flood proofed. Such flood proofing requires that fill be placed so that the ground elevation at the structure is 0.5 foot above the 100-year water surface elevation with a 5-percent slope away from the structure and that provisions be made to prevent back-up flooding. Because of the basement exemption, compliance with the municipal floodplain ordinances is fairly easy. Basements in the area are already constructed of poured concrete because of the heavy soil conditions. Also, flood proofing generally requires only some additional drainage around the structure, and fill needed to grade the surrounding area is usually minimal. For developments along 13th Avenue and many other developments in the city, the fill needed to meet the grading and sloping requirements was obtained from the excavation of the basements. In other areas where the fill requirements are greater, locational benefits appear to be sufficient to justify the added expense. As of September 1980, sites for two new commercial structures in West Fargo had received about 6 feet of fill before starting actual construction.

Areas outside of Fargo, West Fargo, Harwood, Riverside, and their extraterritorial zoning authority are covered by the emergency flood insurance programs. These programs require that sites be "reasonably safe from flooding," that such structures be "anchored to prevent collapse or lateral movement," and that they be constructed with methods and materials which minimize flood damages. Cass County has provided the townships with county maps showing the estimated 100-year elevations along the rivers. Reed Township, which is in the process of developing an ordinance, recommends strongly to all persons building in platted areas that they construct above the estimated 100-year elevation. Land developed by metes and bounds or nonplatted land requires

an engineering survey of the building site showing it to be above the 100-year flood elevation. Because Reed Township has been flooded in the last few years, compliance with this ordinance has been very good. Barnes Township has recently adopted an ordinance similar to Fargo's with the basement exemption, and compliance is required before a permit is issued. Harwood, Horace, Riele's Acres, and other communities in the floodplain recommend that similar precautions be taken as far as practicable.

In 1978, West Fargo issued building permits for 322 residential units, 11 commercial structures, and 71 remodelings. Growth outside the urban core was slower: Reed Township issued 30 residential permits in 1978 and Barnes Township about 17 permits for both commercial and residential structures. Growth in Stanley Township was assumed to be taking place at about the same pace with slightly less growth assumed at Warren and Normanna Townships. Growth since 1978 has slowed considerably (see Changes in Land Use Since 1977, p. F-25).

Because so little flood-free land is available, because compliance with floodplain regulations is relatively inexpensive, and because emergency work is so successful, builders are willing to continue to build in the floodplain. The sentiments of two developers interviewed were basically: "Yes, it's the floodplain, but where isn't it?"

A major factor affecting future development outside existing urban limits is the availability of land. The agricultural land surrounding the municipalities is classified as prime agricultural land. Land of this type is important to the country because of its superior ability to produce "food, feed, fiber, forage, and oil seed crops." (A detailed map showing specific soil types and productivity in the Fargo-West Fargo region became available in January 1980.) The U.S. Department of Agriculture has adopted a policy of

discouraging nonagricultural uses of prime farmland. Currently, however, the USDA has no authority to prevent development of this type, and the county is just beginning to consider the implications of development. Thus, any land in the study area may be converted to urbanized uses. Land availability depends primarily on the willingness of the individual landowner to sell. Several factors may influence such a decision. As farmers retire or reduce their farming operations, it becomes attractive to them to develop their land for urban uses at a higher selling price than the land would command for agricultural purposes. Farmers may also be induced to sell their marginal farmland. This may be land that is slightly less productive, that lies in an uneconomical unit, or, that, as cash cropping becomes more popular, is not suitable for row cropping. Often the land meeting the above requirements is along the Sheyenne River. This land, because of its lighter soil composition, is also more suitable for septic system construction than the heavier clay agricultural soils. An adequate septic system is essential for granting a building permit in the county. In addition to land purchasing, the practice of land trading has been used to acquire land adjacent to the urban areas. Developers will purchase agricultural land outside of the urbanizing area and trade it to local farmers for more developable land in the urban area.

No one developer is involved in developing land strictly in the fringe areas. Most development is done in conjunction with the current landowner. The single most important factor in the development of land in the urban fringe area is the willingness of the current landowner to sell and the availability of financing. Without interviewing specific landowners, only general observations can be made about where development might occur.

Industrial

By 2000, the North Dakota portion of the urban core area will need 92 acres of industrial land. As of 1978, Fargo had 235 acres of vacant platted industrial land which was either improved or scheduled for improvement in the near future. By 2000, West Fargo will have approximately 600 acres of land suitable for industrial development. Riverside, which anticipates no future annexation, has about 200 acres of industrial land still available. Both Riverside and Fargo actively seek industrial users, while West Fargo leaves most industrial promotion in the hands of private developers. Because of this more aggressive policy, most of the industrial development is expected to go to these two communities. West Fargo's industrial land has also had flood problems, contributing to the glut of available land for projected industrial needs. Most of Fargo's industrial land is relatively flood free, and both Fargo's and Riverside's vacant industrial land is convenient to rail and highway transportation. The major land use in Riverside is industrial, and the city has a slight tax advantage over Fargo, with a 1978 mill levy of 247.7 compared to Fargo's mill levy range of 263.6 to 290.1. A projected 45 acres of industrial land in Riverside will be developed by 2000 because of aggressive attraction policies, lower taxes, high percentage of industrial land use, and the minimal amount of fill and landscaping needed to make the land relatively flood free. The rest of the industrial growth is expected to occur in the Fargo industrial parks and along Highways 10 and 52. No new industrial development is expected to take place outside of the urban areas because of the lack of sufficient wastewater treatment and water supplies, the great availability of land in urban areas, and the flood-prone nature of land adjacent to the existing industrial development.

Commercial

Projected commercial acreage needed by 2000 is 288 acres in the cities and 59 res in the fringe area. Most of the commercial development in the frin reas lies in two sections: along a half mile of Highways 10 and 52 between Fargo and West Fargo and a half mile north of Highways 10 and 52 adjacent to I-29. Land in this second area is bounded on three sides by Fargo. These developments are adjacent to similar municipal developments and may be subject to annexation by 2000. It is projected that less than 59 acres of commercial land will be developed outside of the urban areas. Future commercial expansion will depend strongly on the success of the West Acres regional center and the rehabilitation of Fargo's central business district which, if it becomes a strong commercial center, will encourage redevelopment in central Fargo. So far, the redevelopment effort in the central business district seems to be effective.

Commercial development, if it continues its past trend, will be strip development - probably occurring first along Highway 81 South and Highways 10 and 52 between Fargo and West Fargo, adjacent to existing commercial development. Because land zoned industrial along Highways 10 and 52 exceeds demand, it may be converted to commercial uses.

Since West Acres was constructed, 13th Avenue South has become a major east-west route. Expansion of 13th Avenue South to a five-lane road will be completed in 1981. Single-family and multifamily residential development has taken place along 13th Avenue South near West Fargo. Multifamily housing is usually used as a buffer zone between residential and commercial uses. Unless an aggressive zoning policy is implemented, commercial development would probably spread westward along 13th Avenue South from West Acres. Development along these routes would provide approximately 150-200 acres of commercial land. An additional 160 acres of commercial land is available south of West Acres along I-29. Altogether, this totals 310 to 360 acres of commercial land.

The existing pattern of strip development is not completely commercial, but is commercial integrated with industrial, transportation, communication, and multifamily residential. On the basis of existing patterns, roughly 25 percent of this strip land will be in other uses, leaving 251 acres for probable prime commercial development with an additional 54 acres needed for local commercial establishments pocketed in the community and for conversions in the central business district.

Residential

By 2000, 797 acres of land in the North Dakota urban core are projected to be converted to single-family residential use. Of this, 464 acres are projected to be developed in the cities and 333 acres in the fringe area. It is important to emphasize that the definition of fringe area as used by F-M COG does not include the areas of Horace, Harwood, Rivertree, and Brooktree or the Townships of Stanley, Warren, and Normanna. These areas are in the floodplain and within commuting distance of the urban area. In addition, 150 acres for multifamily use are needed. All of this land is projected to come from the cities within the North Dakota SMSA area. A total of 9,336 additional residential units will be needed in Cass County by 2000.

Since price is probably a primary consideration in the choice of housing, some comparisons of price range availability are called for. The Federal Home Administration Section 235 program makes low interest mortgage money available for low-priced new or substantially rehabili[illegible] single-family housing. Single-family housing may be what is ordinarily considered multi-family housing in the form of townhouses or duplexes, provided each unit has an individual sewer and a lot line with a common wall agreement. Maximum sale price varies from year to year. In 1978, the maximum selling price

was $45,600 for a three-bedroom home and $52,800 for a four-bedroom home. Maximum mortgage values were approximately 80 percent of the selling price.

Prior to construction, developers apply to reserve a certain amount of Section 235 money for a number of units in their development. In 1978, 136 Section 235 units were constructed in West Fargo, 246 in nonmetro cities outside the study area, but none in Fargo. Two local developers asked the reason for this both stated that the larger lot sizes required in Fargo increase the land and special assessment costs sufficiently to make it very difficult to construct the homes under the target cost. The Section 235 homes are generally mixed in with other homes in platted subdivisions. Approximately 42 percent of the units constructed in West Fargo in 1978 were Section 235 units.

Apartment rental is an alternative to low income and transient housing. With the expansion of area colleges in the late 1960's and early 1970's, demand for rental units increased rapidly, and apartment construction boomed. Now apartments are overbuilt and vacancy rates are rising. No new apartment construction is expected for some time.

For other residential construction, it is more economical to build a single-family residence in West Fargo than in Fargo, even though Fargo is the largest market area. West Fargo allows a smaller minimum lot size than does Fargo. Most West Fargo developments are constructed on 60-foot lots, but West Fargo is fairly liberal in allowing variances. Most developers can have the land platted and zoned in their most favorable economic mix. In addition, special assessments are lower in West Fargo, primarily because of narrower street allowances and less exacting wastewater specifications. Because of this, one developer estimated a 15-percent difference in selling price between comparable new homes in West Fargo and Fargo. In the recent

past, Fargo development has been in the moderate to high price range, while West Fargo's homes have been in the low to moderate price range.

In addition to a lower initial purchase price, taxes are lower in the West Fargo area. Tax rates in West Fargo in 1978 were 254.29 mills as opposed to 263.60 to 294.19 mills for Fargo. That, coupled with lower initial valuations, reduces taxes considerably for comparable homes in West Fargo.

Based on a random distribution of units and population change, one-third of the acreage needed for residential units will be developed in West Fargo (approximately 203 acres for both single-family and multifamily housing). The most probable location of these acres is east of the existing development in the flood-fringe area.

Although Riverside has very little vacant land reserved for residential growth, it has some land slated for commercial development which is also suited to residential use. Because of its comparatively small size, Riverside may use an estimated 20 additional acres for residential growth, including trailer homes. All other residential development by the year 2000 in the urban core cities is expected to take place in Fargo.

The availability of residential land outside the core cities is subject to the discretion of the current landowners (see discussion of prime farmland as a development factor). Specific projections as to where development will be located in the urban core fringe are difficult to make. In Reed Township, section 9, section 18 next to the river, section 31 NNW¼, and section 19 close to the railway have all been purchased with the intent to develop. This land would provide more than the needed acreage by the year 2000, and most of it is listed as flood free. The most probable pattern of development is similar to what is happening now. Land will be developed first that is fairly

easy to protect against flooding or to flood proof, that has lighter soil which allows a cheaper and more workable septic system, that is not as productive for farming, that is aesthetically pleasing, and that is adjacent to cities. Again, the controlling factor is the desire of the farmer to sell. Land along the Sheyenne River, former pastures, shelterbelt land, and land subject to shallow flooding are expected to be developed first. By 2000, continuous residential development can be expected along the Sheyenne River adjacent to County Road 17 between West Fargo and Horace. This land has not been flooded in recent years and is high enough to protect with private emergency measures. Downstream of West Fargo, development is expected in the sections designated and possibly in Harwood (see below). In addition to these areas, those south of Fargo along Highways 81 and I-29 are likely to be developed, although soil conditions and water supply may delay their development. Isolated pockets of development are expected in the fringe areas, but the location of these 333 scattered acres is at the discretion of the landowners. (All of this land is expected to be developed as single-family residential homes.)

Harwood

Harwood has prepared a comprehensive plan and is developing the ordinances to support it. This plan lists sufficient land in all categories to satisfy any demand created by the projected increase in population.

All property in Harwood is defined as being in a high flood hazard area. Harwood is currently adopting a flood zoning ordinance similar to West Fargo's, with a basement exemption. Future development in Harwood will be substantially flood proofed.

Lisbon

Lisbon is projected to increase very slowly over the next 20 years. Most of the changes in land use up to the year 2000 will involve conversion of vacant land to residential land and changes in type of residential land use in an urban renewal area. New development is planned for east of the urban renewal area and northwest of the existing development. Other undeveloped land is zoned agricultural. Both of these areas lie outside the floodplain.

No detailed Flood Plain Information Report has been prepared for Lisbon. The current guide for evaluating proposed construction under the emergency flood insurance program is the Flood Hazard Boundary Map. The city relies on an informal system of reviewing each building permit application in terms of the distance from the river and the suitability for protection with emergency measures. A more formalized review is required after the community enrolls in the regular insurance program. Sufficient nonfloodplain land is available to direct new growth into these areas.

Valley City

Between 1980 and 2000, the population of Valley City is projected to increase by 9 percent. Land use in each category is anticipated to increase by the same percentage except for parks and public institutions. While parks and other public facilities could be expected to increase as population increases, the greatest share of this category is tied to regional institutions which are not expected to be as sensitive to anticipated local population changes.

Table F-24

Additional acres needed for development by 2000: Valley City

Category	Acres
Single-family residential	38
Multifamily residential	9
Commercial-industrial	22
Total	69

Source: Projected acres increased in proportion to the projected increased population.

The manner in which development occurs at Valley City is similar to that of new development in the West Fargo area. Most residential development is undertaken by private developers who request annexation, plat approval, and extension of public services simultaneously. This package is generally approved after it meets the requirements of the city. Development of industrial land is a joint city, developer, and perhaps Federal venture, while commercial development is undertaken by private individuals.

Since Valley City is still in the emergency flood insurance program, no specific floodplain ordinance directs development out of the 100-year floodplain. The city subdivision regulation does, however, require that development proposed for a flood hazard area designated by the Flood Hazard Boundary Map meet certain qualifications: that no fill or structure be placed within the floodway in any way that impedes, retards, or changes the direction of floodwaters; that no first floor be below the floodplain elevation; and that, where appropriate, diking be done to an elevation greater than the 1979 flood. Currently, four new residential plats have been approved for approximately 150 lots. Three of the subdivisions are well out of the floodplain. About one-third of the

units in the other subdivision required diking and raising the first floor elevations. When a final floodplain map is available, the city anticipates passing a floodplain ordinance similar to West Fargo's, with a basement exemption. Valley City is willing to extend services in almost any direction: additional growth is expected to occur randomly adjacent to the existing development.

Sensitivity

The preceding land use projections are consistent with the flexible future land use projections and zonings made by the municipalities. These are growth-oriented areas that in the past have had few problems with growth and expansion. Strict zoning and planning are just starting to be advocated, and support by the community as a whole is just starting to develop.

Interest Rates - Housing markets are extremely sensitive to interest rate changes. Since this detailed analysis was conducted in 1978, high interest rates have slowed construction significantly in the study area (see the discussion of building permits issued, p. F-26). The reduction appears to be uniform: both rural and urban building declined. Because the population is still growing, demand for residential dwellings continues. Barring a major lifestyle shift, the events of the last 2 years should result in unsatisfied demand that will be satisfied when the economic conditions associated with homeownership are perceived to improve.

GOVERNMENT

Most of the townships in the lower Sheyenne River basin are organized, with elected governing bodies. Of the small towns, most are incorporated and have the mayor-city council form of government. The powers and functions of the cities include property tax assessment, tax levies, incurring indebtedness,

and providing public facilities. West Fargo is governed by an elected city commission which consists of a president and four board members. Riverside has a mayor-council form of government, with the mayor and four (at large) aldermen elected to serve 4-year terms.

PUBLIC SERVICES AND FACILITIES

The populations of the 14 communities within the area vary from 6 to 7,917. Three of the communities (each with populations over 2,000) offer a wide range of public and private services. Only a few services are available in the remaining communities.

Area communities with population exceeding 2,000 provide adequate police and fire protection. Such protection, however, is seldom available in communities with populations less than 100. A majority of the communities with populations between 100 and 2,000 provide fire protection. Municipal water and sewer service are furnished in most communities, the exception being communities with populations under 100.

West Fargo currently employs 38 municipal workers. Its police force of 16 has three clerical employees, an assistant chief, and a chief. Fire protection for West Fargo is contracted with a local volunteer department, an arrangement considered sufficient for the present level of risk. (Fire protection for Riverside is also contracted with this department.)

West Fargo maintains excellent facilities for kindergarten through 12th grade education. The West Fargo-Fargo area also supports various posthigh school institutions (e.g., several business colleges and North Dakota State University).

The best medical services and facilities in the four-county area are concentrated in the Fargo-Moorhead SMSA. These facilities also provide services to West Fargo and Riverside. Statistics indicate that in 1971

the total number of physicians in Cass County was 141,(1) an average of one physician per 522 people. Health care facilities consist of three general hospitals with a licensed bed capacity of 614, or approximately 8.3 licensed beds per 1,000 people(2). Other facilities include nursing and boarding care homes with 540 and 231 beds, respectively, and five clinics(2).

TRANSPORTATION

The lower Sheyenne River basin has three Federal highways and nine State highways. Highways running east to west are I-94 and State Highways 46, 27, 26, 9, 11, and 3. Those running from north to south are I-29, U.S. 81, and State Highways 32, 18, 1, and 38. These roads provide access to other metropolitan areas, including Grand Forks, Bismarck, Omaha, Sioux Falls, Duluth, Minneapolis-St. Paul, and Winnipeg. The highway system in the basin serves most of the counties fairly well; however, many of the county roads are still gravel surfaced and narrow. Improving these roads has become more difficult because of rising construction costs.

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(1) Summary of Health Facilities and Manpower in North Dakota, May 1971, State Comprehensive Health Planning Agency.

(2) U.S. Census, 1970-1972 State Plan, North Dakota, Social Work Manual, Chapter 328, Public & Private Institutions, Public Welfare Board of North Dakota, July 1970. Prepared by Min-Dak staff.

Most goods in the area are transported by truck. Goods are also transported by the Burlington Northern and Soo Line Railroads which provide carload freight shipments. Although all counties have railroad freight service, the amount of service is dwindling. Passenger service by railroads is almost nonexistent. Cass County provides the major air service facilities in the area; the Fargo municipal airport is served by three major airlines. West Fargo, Arthur, and Kindred have airport facilities for light planes. Throughout the remaining counties, a few private airstrips exist, but not all communities are served. An intercity bus line offers daily service between Fargo and other parts of the Nation. However, bus service is limited in most counties, making the automobile a necessity in nearly all rural areas.

Bus, taxi, or rail passenger service is not available in communities with populations under 2,000. Lack of passenger service combined with the absence of essential services, such as grocery stores, clothing stores, and medical services, may decrease the desirability of communities with populations less than 100 for elderly persons and others not capable of providing their own transportation. Medical services are established in all communities with populations over 2,000. Approximately half of the communities with populations between 100 and 2,000 have medical services.

The presence of one or more grain elevator firms in each of the communities with less than 100 persons appears to be the major factor in their existence. An agricultural service and/or industrial sector provides the major economic base in communities with populations over 2,000. Some of the communities of 100 to 2,000 persons may grow as bedroom communities because of their location near larger urban areas.

BEHAVIORAL DAMAGE REDUCTION

The Sheyenne Stage 2 Report stated the intent of the St. Paul District to identify and calculate potential behavioral damages as a part of the benefit-cost analysis for Stage 3 studies. This work, though not specifically required by regulation, was desired in order to show the greater range of economic impacts of flooding in the Sheyenne River basin. However, it was not possible to conduct these studies during Stage 3.

The inability to conduct behavioral damage studies for this study is not a criticism of this procedure. Independent studies conducted by the Institute for Water Resources (IWR) for the Huntington District on the Tug Fork flood control study and in planning stages in Huntington and other Districts have shown even greater potential for this method than was realized when the St. Paul District first decided to employ it on Sheyenne River. The positive policy implications of using a project justification method which focuses on direct flooding impacts to human populations, to supplement current methods focusing on the property damages that they bear, argues strongly for further development and use of this method.

INSTITUTIONAL ANALYSIS

INTRODUCTION

An institutional analysis is a systematic investigation of the organizations and government units within a study area. The institutions that are involved in water and related land resource management in the lower Sheyenne River basin were surveyed to help determine the implementability of various water resource development alternatives. The information developed in this analysis includes:

a. An inventory of interested organizations and their characteristics, with attention to those organizations participating in the Corps study process.

b. A summary of water and related land use legislation.

ORGANIZATIONAL SETTING

Inventory of Organizations

The inventory includes 54 organizations having concern or responsibility for water resource management and related land use. Thirty of them were contacted by phone and the remainder through personal interviews. The organizations are listed below.

Audubon Society (AUDB)
North Dakota Wildlife Federation (NDWF)
Sierra Club (SIERR)
League of Women Voters (LWV)
North Dakota Stockman's Association (NDSA)
Natural Science Society (NSS)
North Dakota Farmers Union (NDFU)
North Dakota Farm Bureau (NDFB)
North Dakota Association of Soil Conservation Districts (NDASC)
Greater North Dakota Association (GNDA)
North Dakota League of Cities (NDLC)
Minn-Dak Farmers Flood Control Association (MDFFC)
Sheyenne Valley Association (SVA)
Sheyenne Valley Grazing Association (SVGA)
Southeast Cass Rural Water Users (SECRWU)

Barnes County Wildlife Federation (BCWF)
Tri-County Irrigation District (TCID)
Fargo Wildlife Club (FWC)
Kindred Gun and Wildlife Club (KGWC)
Lower Sheyenne River Citizens Commitee (LSRCC)
Lake Agassiz Regional Council (LARC)
Red River Regional Council (RRRC)
South Central Regional Council (SCRC)
Cass County Soil Conservation Service (CCSC)
Cass County Health Department (CCHD)
Southeast Cass Water Management Board (SEWMB)
Cass County Drain Board (CCDB)
Cass County Park Board (CCPB)
Cass County Planning Commission (CCPC)
Richland County Township Association (RICTA)
Richland County Park Board (RICPB)
Richland County Planning Commission (RICPC)
Ransom County Water Management Board (RACWMB)
Ransom County Park Board (RACPB)
Ransom County Planning Commission (RACPC)
Barnes County Water Management Board (BCWMB)
Barnes County Planning Commission (BCPC)
Cass County Township Officers Association (CCTOA)
Richland County Township Officers Association (RICTOA)
Ransom County Township Officers Association (RACTOA)
Barnes County Township Officers Association (BCTOA)
Fargo-Moorhead Metropolitan Council of Governments (FMMCG)
Fargo Planning Commission (FPC)
West Fargo Planning Commission (WFPC)
Kindred City Government (KCG)
Horace City Government (HCG)
Lisbon City Government (LCG)
Valley City Planning Commission (VCPC)
Reed Township (RT)
Harwood Township (HT)
Barnes Township (BT)
Stanley Township (ST)
Warren Township (WT)
Normanna Township (NT)

There are numerous ways of classifying organizations. Given the distribution of organizations in this survey, the organizations were divided according to their geographical jurisdictions and governmental affiliation. The organizations fall into the following categories:

Nongovernment State level -	11
Nongovernment regional level -	9
Regional governments -	3
County governments -	18
Local governments -	13

Because of the nature of the survey, county organizations were most frequently interviewed and include over a third of the organizations.

Almost half of the organizations were local governments when classified by primary interest. About a fifth of the organizations were civic or service, and another tenth were environmental groups. Only one was primarily recreational. Four were professional organizations, and the remainder were some other form of government unit. Table F-25 summarizes selected characteristics of the profiled organizations.

Many respondents thought their organizations did not have charters (24 of 54). Also, a large number do not have published goals (34 of 54). Twenty-two of the 54 respondents said that last year's budget was not available.

An important portion of the work in all five categories of organizations is done by voluntary staff. In fact, only 20 of the organizations have full-time staff. What emerges in this survey is the sizable portion of organizations not classified as voluntary associations in the traditional sense that nonetheless operate by means of voluntary work. This is true in all categories of government except regional (note that only three of the organizations are in this category).

Almost all of the respondents consider their organizations to be permanent (two of 54 are not certain). Thirty-four of the organizations said they were subunits of a larger organization. Five said they had jurisdiction over other subunits. Forty of the respondents said their organizations' activities were subject to specific regulations concerning water resources management and related land use.

Organizational Functions and Funding

All organizations included in the survey indicated that they had some concern about or responsibility for water resource management and related land use in the basin. The organizations were also questioned as to their specific activities concerning water and related land use. Table F-26 summarizes the responsibilities and areas of interest for these organizations.

The most frequent activity mentioned was planning (33) followed by resource use and control (23). About a fourth of the organizations saw their activities as regulation, public education, or lobbying. Nine are involved in research. Only three said a primary activity was legislation.

About two-thirds of the respondents said their primary activities were related to quality, use, supply, and flooding. The highest proportion (46 of 54) reported water-related land use as their primary activity. The lowest category of activity was in wildlife, with 23 of 54 respondents considering this as a primary area of activity. Local and county governments reported fewer activities associated with water quality, use, and supply than did other levels of government.

The respondents were asked to state the goals and activities of their organizations. Their responses are summarized in table F-27. Planning was the most frequently stated activity, involving over half of the organizations. Development and policy making were activities in about a fourth of the organizations. Legal-political activities were cited by about one-fifth of the organizations.

Goals and activities appeared to be somewhat distinct although activities and goals were more closely allied in local governments than in the other four categories of government. Some of the cited goals relate to mediation and coordination functions, particularly in the case of regional governments.

Table F-25 Selected characteristics of organizations

Kind of organization	Number	Characteristic: Has charter	Published goals	Full-time staff	Voluntary staff	Specific regulations	Permanent organization	Organization a subunit	Jurisdiction other units	Contact other organizations	Available budget
Nongovernment State	11	11	9	8	7	6	11	8	4	11	4
Nongovernment regional	9	5	3	2	9	4	8	3	0	9	3
Regional governments	3	3	3	3	0	3	2	0	0	3	3
County governments	18	5	2	3	17	14	18	18	0	17	14
Local governments	13	6	3	4	11	13	13	5	1	13	8
Total	54	30	20	20	44	40	52	34	5	53	32

Source: Phone and personal interviews completed September 1977.

Table F- 26 Responsibilities and concerns of organizations

Kind of organization	Functional responsibility: Financial	Regulation	Implementation	Operation	Planning	Legislative	Research	Public education	Lobbying	Resource use and control	Water resource concerns: Quality	Use	Supply	Flooding	Wildlife	Land use	Number in category
Nongovernment State level	0	0	1	0	1	0	8	8	7	8	10	10	10	9	8	9	11
Nongovernment regional level	0	0	0	1	3	0	0	4	3	8	8	8	8	4	7	8	9
Regional governments	0	0	1	0	3	2	0	2	1	2	3	3	3	3	2	3	3
County governments	0	7	6	4	14	1	1	1	1	2	9	10	9	13	6	15	18
Local governments	0	6	2	1	12	0	0	0	0	3	4	6	7	10	0	11	13
Total	0	13	10	6	33	3	9	15	12	23	34	37	37	39	23	46	54

Source: Telephone and personal interviews completed September 1977.

Table F-27 Stated activities and goals of organizations

Kind of organization	Number	Activities: Education	Activities: Planning	Activities: Policy	Activities: Development	Activities: Management	Activities: Legal-political	Activities: General water and land use	Goals: Education	Goals: Planning	Goals: Policy	Goals: Development	Goals: Management	Goals: Conservation	Goals: Legal-political
Nongovernment State	11	8	2	8	2	3	8	0	6	1	1	0	0	7	19
Nongovernment regional	9	4	3	5	3	3	0	0	1	2	1	0	3	2	4
Regional government	3	2	7	0	0	0	0	0	0	0	0	3	0	0	6
County government	18	4	7	1	4	10	2	7	0	5	0	3	9	0	8
Local government	13	0	12	1	5	3	0	7	0	14	0	7	6	0	2
Total	54	18	31	15	14	19	10	14	7	22	2	13	18	9	29

Source: From phone and personal interviews completed September 1977.

Table F-28 Major and minor sources of funding of organizations

Kind of organization	Major source of funding: Federal appropriations	Federal grants	State appropriations	Local tax	Private gifts, memberships	Private grants	Other sources	Minor source of funding: Federal appropriations	Federal grants	State appropriations	Local tax	Private gifts, memberships	Private grants	Other sources
Nongovernment State	0	0	0	0	11	1	2	1	1	0	0	0	0	0
Nongovernment regional	0	1	1	0	6	0	3	0	0	0	0	1	1	0
Regional governments	1	2	1	1	0	0	0	0	0	1	1	0	0	0
County governments	1	0	0	14	0	0	3	0	1	0	0	0	0	1
Local governments	1	0	1	12	0	0	0	9	1	3	1	0	0	0
Total	3	3	3	27	17	1	8	10	3	4	2	1	1	1

Source: From phone and personal interviews completed September 1977.

These goals probably reflect the historical process and development of those bodies. However, some of the county governments also saw these kinds of functions as their goals.

Funding sources were classified as major and minor. Respondents were provided with a list of possible funding sources. A summary of the responses is in table F-28.

The responses were characteristic of government and nongovernment organizations. Nongovernment State and regional level organizations were funded primarily by private gifts and memberships. Two nongovernment regional organizations received State or Federal funds. Regional governments received funding from various levels of government. County governments were almost entirely funded by local taxes, as were local governments. However, local governments frequently reported Federal appropriations as a minor source of funds.

PARTICIPATION IN THE CORPS STUDY PROCESS

A part of the institutional analysis examined the anticipated involvement of 39 of the 54 organizations which were interviewed in depth in a flood control study by the Corps of Engineers. These 39 organizations were surveyed to determine the likelihood of their involvement with the Corps; whether they anticipated being involved directly or indirectly; and, if indirectly, through what other organizations. The 39 organizations are:

State Level Organizations

Agricultural Stabilization and Conservation Service State Commission (ASCSSC)
Bureau of Reclamation (BR)
United States Fish and Wildlife Service (USFWS)
Environmental Protection Agency-Bismarck Office (EPA)
United States Soil Conservation Service-Bismarck Office (SCBS)
State Water Commission (SWC)
State Department of Health (SDH)
North Dakota Game and Fish (NDGF)
North Dakota State Parks and Outdoor Recreation (NDSPOR)
North Dakota State Planning (NDSP)
Garrison Diversion Conservancy District-Carrington Office (GDCDC)

Nongovernment Organizations

North Dakota Wildlife Federation (NDWF)
Sierra Club (SIERR)
Audubon Society (AUDB)
League of Women Voters (LWV)
Minn-Dak Farmers Flood Control Association (MDFFC)
Lower Sheyenne River Citizens Committee (LSRCC)
Sheyenne Valley Association (SVA)
Sheyenne Valley Grazing Association (SVGA)
Southeast Cass Rural Water Users (SECRWU)
Barnes County Wildlife Federation (BCWF)

Regional Organizations

Souris-Red-Rainy River Committee-Upper Mississippi River Basin Commission (SRRRC)
Lake Agassiz Regional Council (LARC)
South Central Regional Council-Jamestown Office (SCRC)
Red River Regional Council (RRRC)
United States Forest Service-Lisbon Office (USFSL)

City Organizations

Fargo Moorhead Metropolitan Council of Governments (FMMCG)
Fargo Planning Commission (FPC)
West Fargo Planning Commission (WFPC)
Valley City Planning Commission (VCPC)
Lisbon City Government (LCG)
Kindred City Government (KCG)
Horace City Government (HCG)

County and Township Organizations

Cass County Soil Conservation Service (CCSCS)
Cass County Health Department (CCHD)
Cass County Township Officers Association (CCTOA)
Richland County Township Officers Association (RICTOA)
Ransom County Township Officers Association (RACTOA)
Barnes County Township Officers Association (BCTOA)

The responses to the organizational interrelations portion of the survey are summarized in figure F-1. Respondents' groups are categorized by kind of organization.

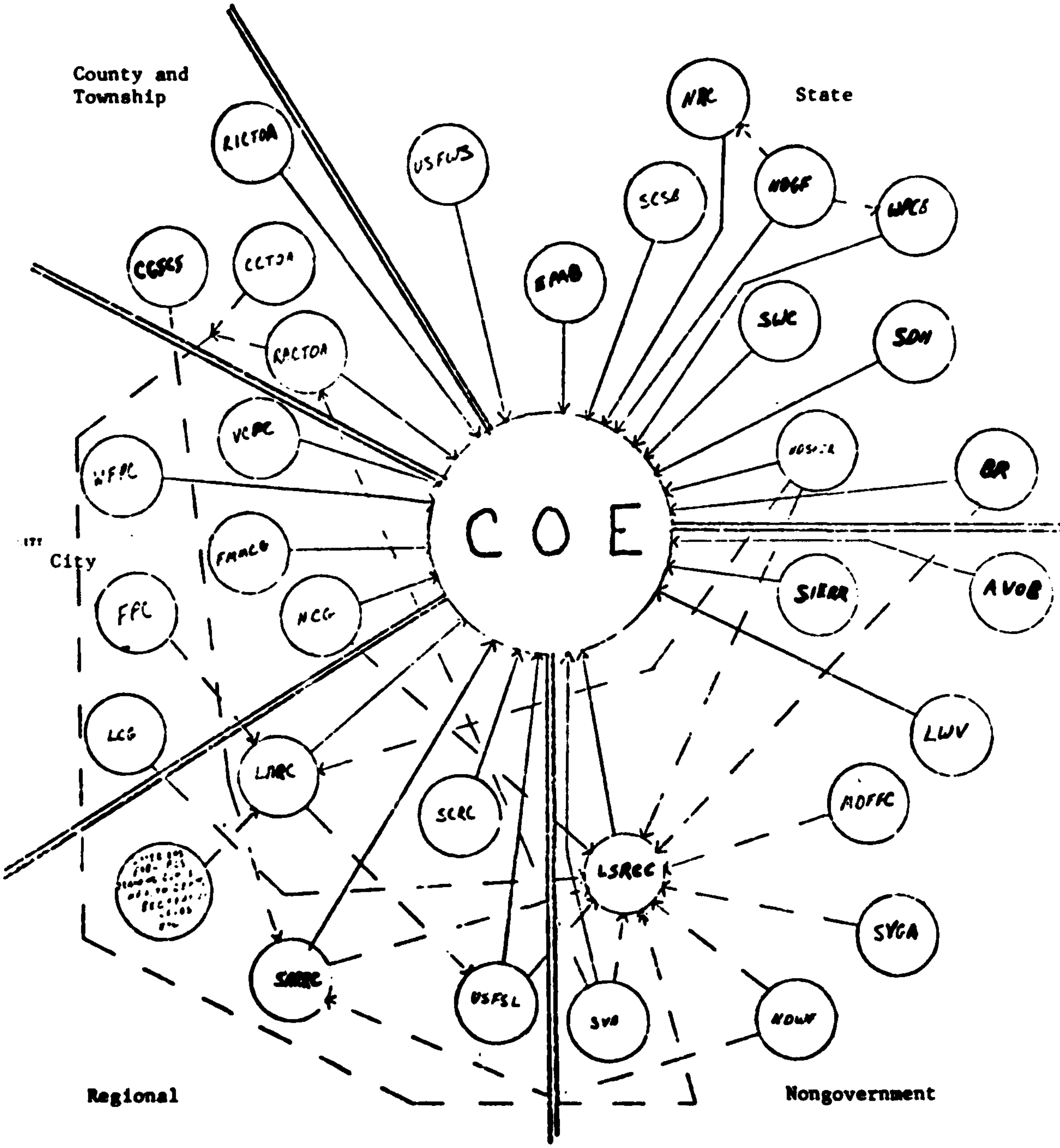
Twenty-three of the 39 organizations said they would be directly involved in the study and 21 said they would be indirectly involved. Ten respondents said they would not be directly involved and seven said they would not be indirectly involved. The remainder were uncertain if they would be either directly or indirectly involved. None of the total groups said they definitely would not be involved either directly or indirectly. In sum, a firm majority anticipated involvement, either directly or indirectly, in the flood control study by the Corps of Engineers. A large share of indirect involvement would be through the Lower Sheyenne River Citizens Committee.

WATER AND RELATED LAND USE LEGISLATION

This section provides a synopsis of water and related land use legislation. Federal, State and local levels of government have jurisdiction over water and related land use in the lower Sheyenne River basin. The Federal Government's legislation covers broad areas of water and related land resource use. The State government, especially the Water Commission and Department of Health, has specific regulations and legislation concerning water resources in general. Local governments are concerned with specific water and related land use rules and regulations only within jurisdictional boundaries.

Townships may influence water and related land resources through comprehensive zoning regulations. However, enforcement is possible only through court action. From review of township ordinances, it is apparent that township zoning has been done primarily to preserve agricultural areas and to encourage the orderly placement of utility lines.

Figure F-1 Participating agencies



Solid lines indicate direct participation; broken lines indicate participation through another organization.

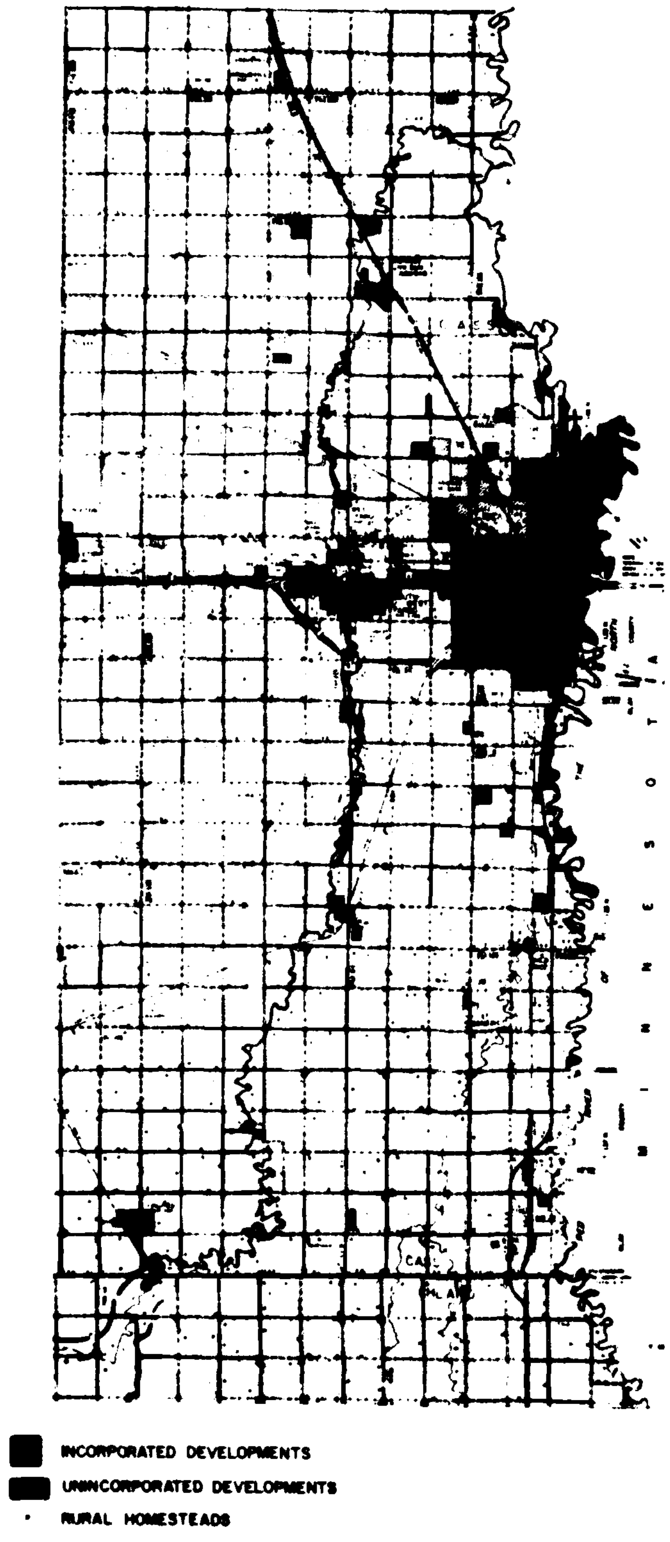
Municipalities have statutory authority to enact rules and regulations in areas such as implementing land use or zoning ordinances and promoting the general health and welfare of citizens. They may contract to construct public works projects pertaining to pollution, water supply, conservation and control, sewage disposal, and drainage.

Several county boards, commissions, and districts are responsible for regulating water and related land use management. County Park Boards have the authority to regulate, supervise, control, and manage any water or land area over which the county has jurisdiction for park or recreational purposes. All four of the counties in the area (Barnes, Cass, Ransom, and Richland) have park boards. Water Management Districts are the local organizations with the most authority for water and related land use decision making. They may sue and be sued, have the power of eminent domain, and can regulate water use. *Irrigation Districts* and Flood Irrigation Districts may sue and be sued, may contract for construction, and have the power of eminent domain. Soil Conservation Districts may exercise the powers ordinarily exercised by a governmental subdivision of the State and have authority to institute land use regulations for conserving soil and water resources. County Superintendents of Public Health and Local Boards of Health have the authority to enforce all laws pertaining to life and health in the county. However, most county regulations are not concerned with water as an issue. Regional planning commissions have the same powers as are granted to counties, municipalities, organized townships, and other political subdivisions in preparing ordinances.

The two prominent regulating agencies of the State are the State Water Commission and the State Department of Health. Others include the Outdoor Parks and Recreation Agency, Game and Fish Department, Geological Survey,

and the Garrison Diversion Conservancy District. The State Water Commission has nearly complete authority over and responsibility for water resources. The State Department of Health is responsible for regulating the quality of water throughout the State. The Outdoor Parks and Recreation Agency is the planning and coordinating agency for related programs on all government levels. The Garrison Diversion Conservancy District was established to develop and use land and water resources to enhance the economic welfare and prosperity of the people of North Dakota. The State Game and Fish Department promulgates rules and regulations regarding hunting and fishing in the State. The State Geological Survey is responsible for studying, mapping, monitoring, and analyzing the geological resources of the State, including its ores, waters, and other useful materials. The State Planning Division serves in an advisory capacity to local and regional planning agencies.

Most water and related land use decisions in North Dakota can be made without reference to Federal legislation. In some instances, decision-making must consider Federal statutes. Relevant legislation includes the Federal Water Pollution Control Act, the National Environmental Policy Act, the Flood Disaster Protection Act of 1973, the Safe Drinking Water Act, the Wild and Scenic Rivers Act, and the Soil Conservation and Domestic Allotment Act.



PHASE I GENERAL DESIGN MEMORANDUM
SOUTHEASTERN CASS COUNTY/LOWER
SHEYENNE RIVER AREA.

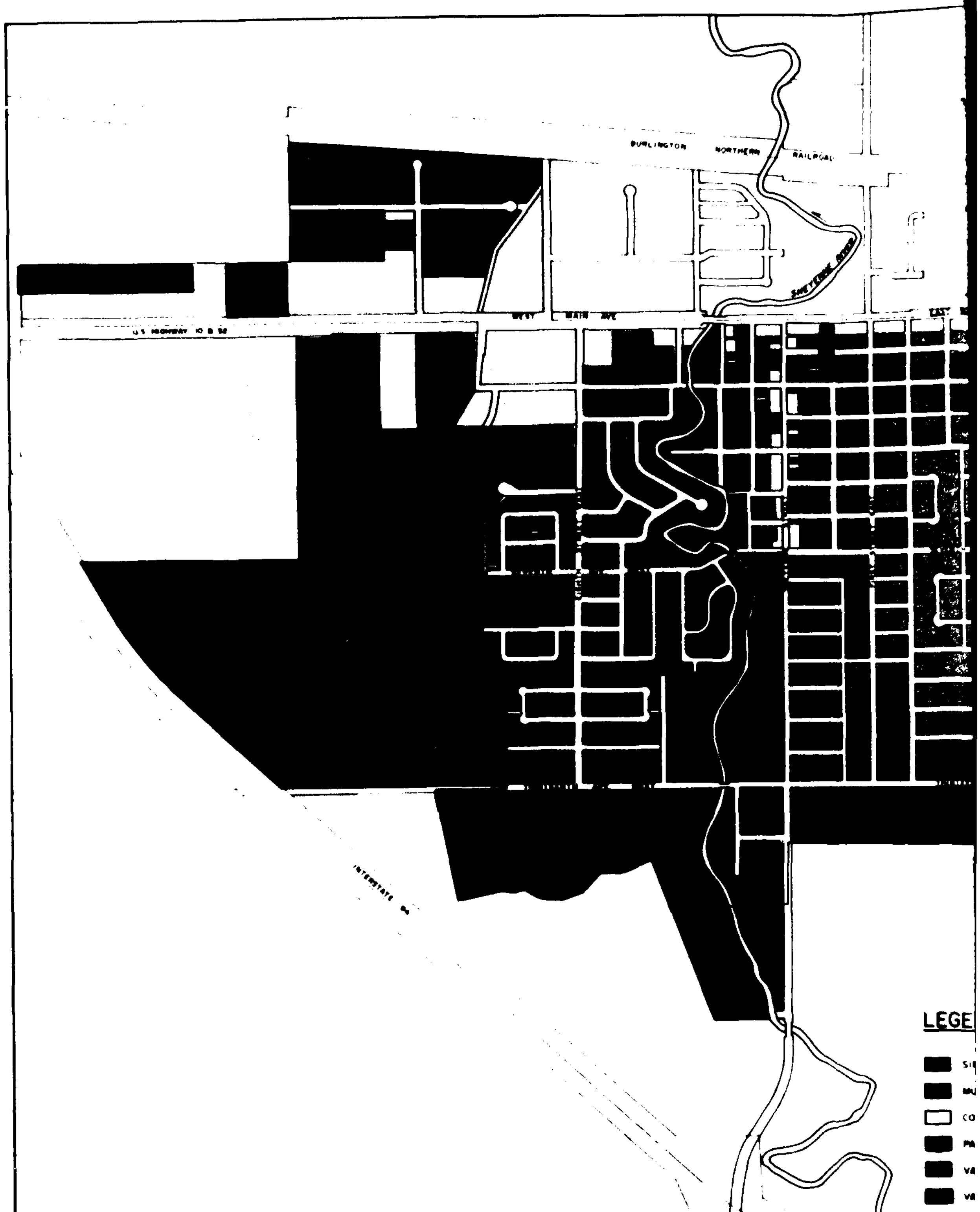
SHEYENNE RIVER, NORTH DAKOTA

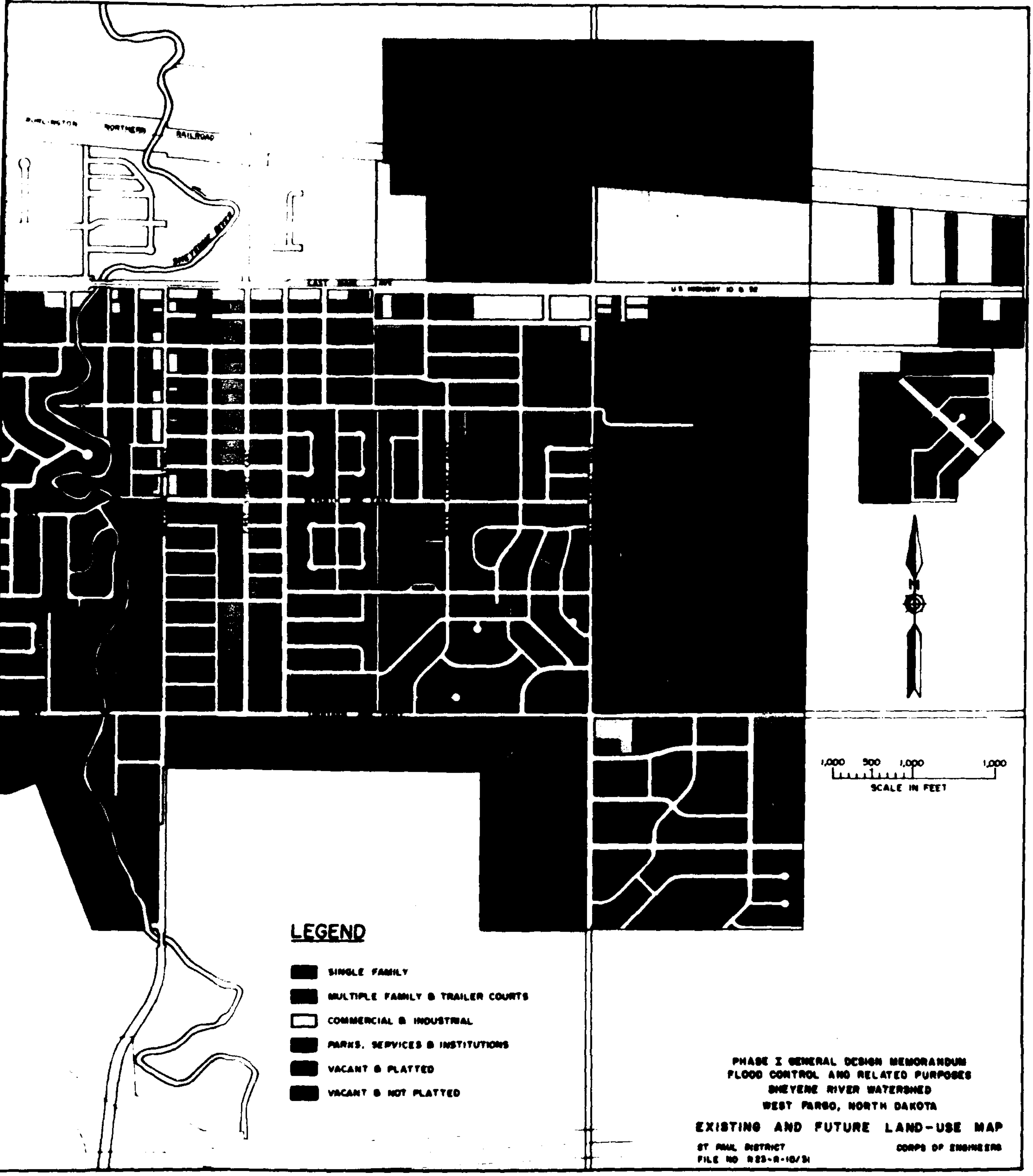
URBAN AREAS, RURAL DEVELOPMENTS, AND HOMESTEADS

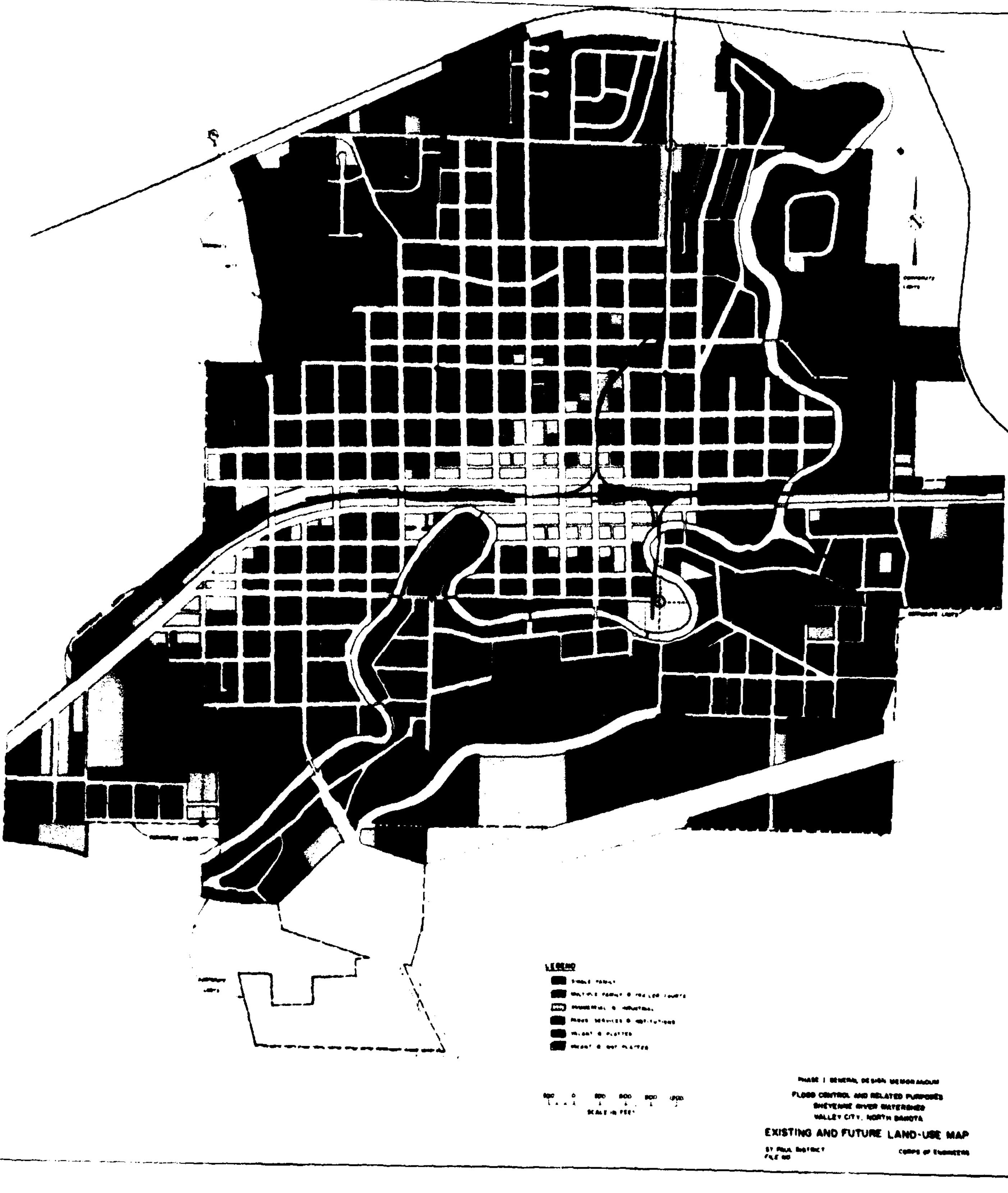
ST PAUL DISTRICT

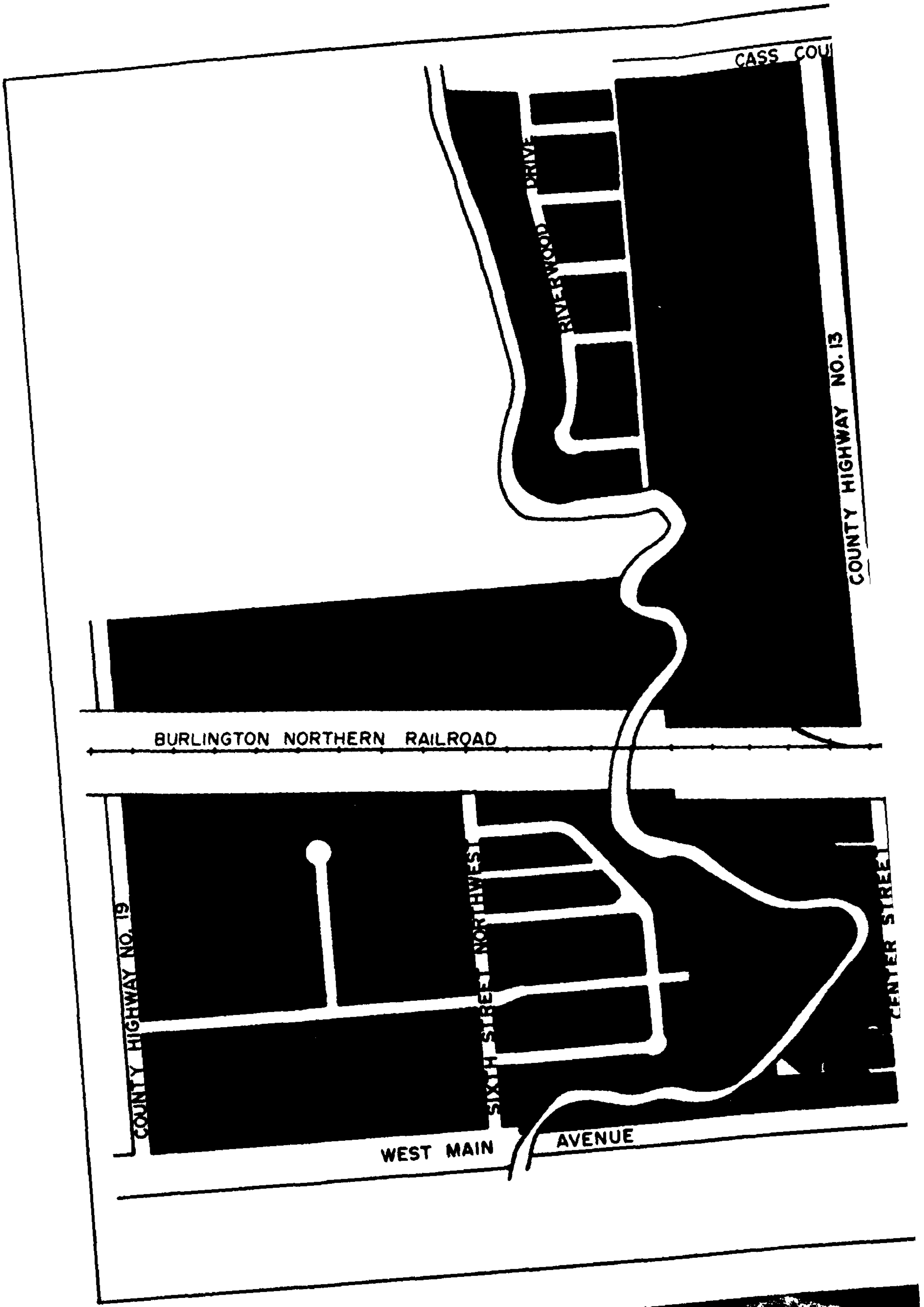
CORPS OF ENGINEERS
1 AUGUST 1979

U.S.GPO:1979-665-155/80-6

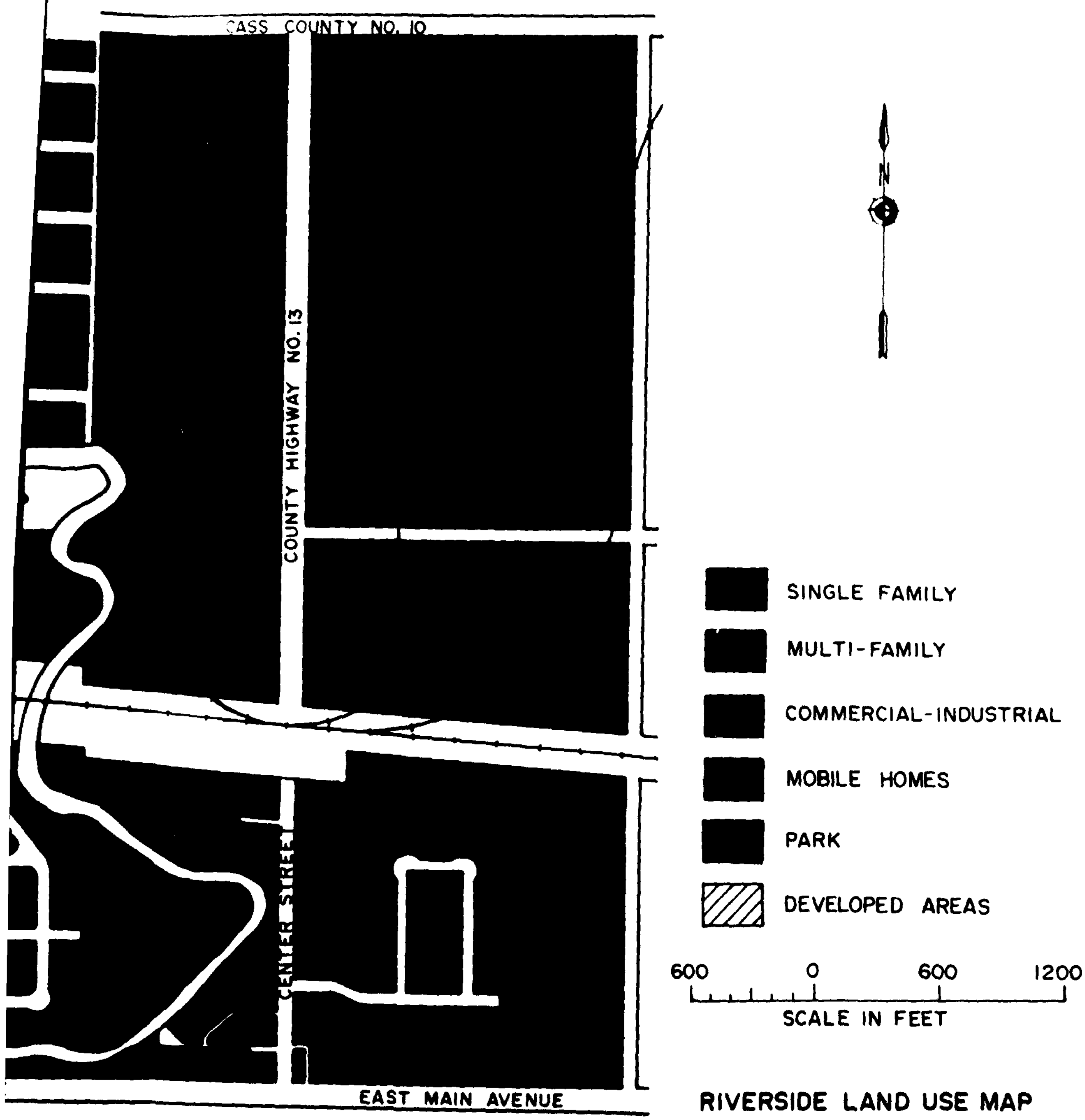

BURLINGTON NORTHERN RAILROAD
WEST MAIN AVE
EAST
LEGE


BURLINGTON NORTHERN RAILROAD
U.S. HIGHWAY 10 & 52
N
1,000 500 1,000 1,000
SCALE IN FEET
LEGEND
SINGLE FAMILY
MULTIPLE FAMILY & TRAILER COURTS
COMMERCIAL & INDUSTRIAL
PARKS, SERVICES & INSTITUTIONS
VACANT & PLATTED
VACANT & NOT PLATTED
PHASE I GENERAL DESIGN MEMORANDUM
FLOOD CONTROL AND RELATED PURPOSES
SHEYENE RIVER WATERSHED
WEST FARGO, NORTH DAKOTA
EXISTING AND FUTURE LAND-USE MAP
ST PAUL DISTRICT
CORPS OF ENGINEERS


PHASE I GENERAL DESIGN MEMORANDUM
FLOOD CONTROL AND RELATED PURPOSES
SHEYENNE RIVER WATERSHED
VALLEY CITY, NORTH DAKOTA
EXISTING AND FUTURE LAND-USE MAP
CORPS OF ENGINEERS



CASS COU
RIVERWOOD DRIVE
COUNTY HIGHWAY NO. 13
BURLINGTON NORTHERN RAILROAD
COUNTY HIGHWAY NO. 19
SIXTH STREET NORTHWEST
CENTER STREET
WEST MAIN AVENUE



RIVERSIDE LAND USE MAP
RIVERSIDE, NORTH DAKOTA

☆ U.S.GPO:1979-665-188/81-6

APPENDIX G

ECONOMIC ANALYSIS - FLOOD DAMAGES AND BENEFITS

GENERAL REEVALUATION

AND

ENVIRONMENTAL IMPACT STATEMENT

AUGUST 1982

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APPENDIX G

ECONOMIC ANALYSIS - FLOOD DAMAGES AND BENEFITS

FLOOD DAMAGE AREAS

Sheyenne River flood damages can be divided into two general areas: upstream of the city of Kindred (river mile 68.1) and downstream of Kindred to the confluence of the Sheyenne River and the Red River of the North (see plate G-1). Upstream of Kindred, numerous small tributaries are deeply incised in narrow, steep-walled valleys. Thus, flood damages are restricted to the broader floodplain bordering the main stem. The valley floor varies in width from about 800 feet below Lisbon to 1.5 miles a few miles above Cooperstown. Floods damage crops and farm properties, rural roads and bridges, and the communities of Valley City and Lisbon.

The Sheyenne River flows generally southeast in the vicinity of Valley City and Lisbon. In Valley City, the floodplain is relatively narrow, usually one-half mile or less, with adjacent terrain rising as much as 200 feet above the floodplain. Included in the floodplain are the original residential areas, much of the downtown business area, and the State Teachers College campus. Later residential construction has taken place on higher ground, but considerable undeveloped platted property is still in the floodplain. In Lisbon, the floodplain averages between 500 and 1,500 feet wide and includes both residential and commercial properties.

Below Kindred, the river flows northward through a rapidly developing urban area adjacent to the river to a point about 2 miles downstream of Harwood. Then it follows an eastward course to its confluence with the Red River of the North. The Red River of the North flows north into Canada.

The basin below Kindred is relatively flat, with a floodplain varying in width from 7 to 10 miles. Between Kindred and West Fargo, the Wild Rice and Red River floodplains lie east of and adjacent to the Sheyenne River basin. The Maple and Rush Rivers flow into the Sheyenne River downstream of West Fargo

and upstream of Harwood. Large floods, such as those in 1882 and 1887, inundated approximately 100,000 acres of cropland in the lower Sheyenne River valley (see plate G-1). Large Sheyenne River floods intermingle with Wild Rice, Maple, Rush, and Red River waters.

West Fargo and Riverside lie about midway between Kindred and the mouth of the Sheyenne River. Flooding at West Fargo may reach depths of 3 to 6 feet because most of the community, located on both sides of the river, lies below the top of the natural levees flanking the river. Most of the two communities lie in the 100-year floodplain.

Other communities in the basin are also subject to flooding. These include Horace, Harwood, Argusville, and Gardner. Horace is upstream of West Fargo; the others are downstream. Horace and Harwood are adjacent to the Sheyenne River. Argusville is about 3 miles from the river and is subject to damage from large floods. Gardner is north of Argusville, on the fringe of the 100-year floodplain about 8 miles from the Sheyenne River. Each of these communities has potential residential, commercial, and public damages.

Residential developments, including subdivisions and individual homes, have been constructed adjacent to the river, both upstream of West Fargo to Horace and downstream of West Fargo to the vicinity of Harwood. Plates G-1 and F-1 show the general locations of the subdivisions and individual residences in the study area.

The soil in the lower valley is characterized by a thick, black, organic topsoil and limey subsoil. This type of soil covers most of the flat and nearly featureless glacial Lake Agassiz plain. The plain has a northward slope of about 1½ feet per mile and an eastward slope ranging from 1 foot per mile near the Red River to 2 feet per mile farther west. Natural drainage in the lake plain is not well integrated, and a large part of the runoff is carried by man-made drains. The Fargo silty clay has a minor wetness condition.

In this type of soil, internal soil drainage, surface drainage, and high water tables present minor problems to existing cultivation and pasture use. Flooding usually occurs when rainfall or snowmelt exceeds the infiltration rate of the soil.

Recurring flooding caused by snowmelt and heavy rains has caused millions of dollars of damage in the lower basin through crop inundation and delayed seeding. Other losses include soil erosion and damage to farmhouses, barns, stored crops, machinery, and other farm property. Highway detours and general inaccessibility during floods of long duration account for further losses to the public. Because of the short growing season, a late spring flood can delay seeding and cause loss of production and income for the existing or a substitute crop. A summer flood can cause partial or complete loss of crop and income for the year.

The flood damage estimates for the communities were based on data acquired from field damage surveys in 1961, 1965, 1966, 1968, 1976, and 1977. Agricultural estimates were based on field data gathered in 1966, 1967, and 1977. The following table lists the urban damage centers and rural damage reaches analyzed. It indicates the approximate elevations and discharges at which damages begin.

Table G-1 - Elevations and discharges at which flood damages begin

Community or reach	Reference point	Location of reference point (Sheyenne River mile)	Elevation (feet, msl, 1929)	Approximate discharge (cfs)
Urban and rural-residential (nonurban) damage reaches				
Valley City	Valley City - USGS gaging station	253.0	1211.4	2,300
Lisbon	Lisbon - USGS gaging station	162.1	1080.0	3,150
Reach 5-A (Kindred to Horace)	Kindred - USGS gaging station	68.1	941.9	2,800
Reach 5-B (Horace to West Fargo)	Horace - staff gage	40.1	913.7	2,800
Horace	Horace - staff gage	40.1	909.5	2,100
West Fargo	West Fargo	26.6	897.5	2,950
Reach 5-D (West Fargo to U.S. 29)	Mouth of the Maple River	19.8	891.4	-
Reach 5-E (U.S. 29 to Red River of the North)	Mouth of the Maple River	11.0	891.2	-
Argusville	Mouth of the Maple River	11.0	892.2	-
Gardner	Mouth of the Maple River	11.0	894.25	-
Brooktree Park	Mouth of the Maple River	11.0	890.0	
Harwood City	Mouth of the Maple River	11.0	890.0	-
Rivertree Park	Mouth of the Maple River	11.0	890.0	-
Grand Forks, North Dakota	Grand Forks - USGS gaging station	296.0 (Red River of the North)	816.0	29,000
Rural damage reach				
R-1 from Warwick to Lake Ashtabula	Cooperstown - USGS gaging station	5 miles east of Cooperstown at mile 317.3	1285.7	1,500
R-2 from Baldhill Dam to Northern Pacific Railway bridge at Kathryn	Valley City - USGS gaging station	253.0	1206.64	1,050
R-3 from Northern Pacific Railway bridge at Kathryn to Soo Line Railroad	Lisbon - USGS gaging station	162.1	1076.5	2,000

Table G-1 - Elevations and discharges at which flood damages begin (cont)

Community or reach	Reference point	Location of reference point (Shevenne River mile)	Elevation (feet, msl, 1929)	Approximate discharge (cfs)
Rural damage reach (cont)				
R-4 from Soo Line Railroad to mile 76.2	Kindred USGS gaging station	68.1	1074	1,500
Reach 5-A[1] (Kindred to Horace)	Kindred - USGS gaging station	68.1	935.8	-
Reach 5-B (Horace to East I-94)	Horace - staff gage	40.1	911.5	550
Reach 5-C (East I-94 to Highways 10 and 52[2])	West Fargo - USGS gage	24.5	888.3	725
Reach 5-D (Highways 10 and 52 to South I-29)	Mouth of Maple River	19.8	883.8	-
Reach 5-E (I-29 to Red River of the North)	Mouth of Maple River	19.8	883.8	-
R-6 from mouth of Sheyenne River to Hendrum	Halstad, Minnesota - USGS gaging station	RRN river mile 375.2	852.0	16,400
R-7 from Hendrum to Grand Forks County line	Halstad, Minnesota - USGS gaging station	RRN river mile 375.2	852.0	16,400
R-8 from Grand Forks County line to mile 291.8	Grand Forks-USGS gaging station	RRN river mile 296.0	815.0	27,000
R-9 from mile 291.8 to mile 212.3	Oslo, Minnesota - wire weight gage on Minnesota State Highway 1 bridge	RRN river mile 271.1	802.5	20,000
R-10 from mile 212.3 to international boundary	Drayton, North Dakota - USGS gaging station	RRN river mile 207.0	788.5	25,000

(1) Reach 5 is the Cass County reach in the lower Sheyenne River valley. Reaches 5-A, 5-B, 5-D, and 5-E refer to the structural development in these reaches and are included in the urban damage analysis. Agricultural reaches have also been broken down into 5-A, 5-B, 5-C, 5-D, and 5-E.

(2) Reach 5-C is the West Fargo reach.

After Stage 2 analysis of alternatives, it was determined that stage changes downstream of reach 5 were approximately 0.1 foot. The hydraulic model is accurate only for stage changes greater than 0.2 foot. Reaches 6 through 10 and Grand Forks are not displayed further in this analysis. No remaining alternatives affect reach 1. That reach was dropped from the Stage 3 report.

FLOOD DAMAGE CLASSIFICATIONS

For this report, flood damage data have been collected and classified as follows:

1. Urban - Includes flood damages to residences, business places, industries, churches, schools, automobiles, house trailers, public property, and the contents of all these facilities. Also included are damages to streets and utilities, such as water, gas, electric, sanitary sewer, storm sewer, and telephone systems; loss of wages and profits; expenditures for temporary housing; cleanup costs; and extra expenses for flood relief and additional fire and police protection.

2. Agricultural - Consists of crop and pasture damage, including costs of replanting, refertilizing, additional spraying, reduced crop yields, loss of animal pasture days, and other similar flood losses.

3. Other agricultural - Includes land damage from scour and gully erosion and deposition of undesirable material; livestock and poultry losses; damages to equipment, fences, and farm buildings (excluding residences) and contents; and damages to irrigation and drainage facilities.

4. Transportation - Includes damage to railroads, highways, roads, airports, bridges, culverts, and waterways not included under urban damages. Also included are vehicle detour costs and added operational costs for railroads and airlines.

UPDATING OF DAMAGES AND BENEFITS

No new detailed damage information has been gathered since 1977. All elevation- or discharge-damage relationships represent the 1977 development condition. Since 1977, considerable development has taken place in West Fargo, Riverside, Harwood, and the surrounding subdivisions. Most of this development conforms to floodplain regulations as discussed in Appendix F. In simple terms, these regulations require that first-floor elevations be above the 100-year flood elevation; basements must be of nonporous materials, generally poured concrete; and drainage slopes away from the structures. Generalized estimates about interim damage growth will be made at the end of the detailed flood damage analysis.

Damages and benefits have been updated to October 1980 prices so they can be compared with the costs of the alternatives. The method of updating used for each damage category is summarized below.

AGRICULTURAL

A detailed reanalysis was performed on two sample reaches (5-B and 5-D) using current normalized prices issued on 1 October 1980 and 1980 farm management budgets. In addition to these steps, the 1978 and 1979 floods were added to the flood history. Average annual damages per acre for reach 5-B decreased from $50.80 to $33.53 and for reach 5-D from $57.52 to $34.24. The 1980 damage per acre is 66 percent of the comparable figure for reach 5-B and 60 percent of the 1978 average for reach 5-D. On the basis of similar land use, damages per acre for reaches 2 through 5-C were reduced to 66 percent of their 1978 value. Damages for reaches 5-D through 5-E were reduced to 60 percent of their 1977 weighted damages per acre.

Tables G-12 and G-15 show different area flooded relationships for some historic flood events. The elevation-area flooded relationship for reach 5-B was derived using the zero point to damage plus the only three historic floods for which outlines were available. These three events were the 1969 flood, the 1975 summer flood, and the 1897 flood. The two floods used in the flood history show the same number of acres flooded on both tables G-12 and G-15.

Table G-12 was developed for the stage 2 report before detailed backwater computations were completed. Discharges at Kindred were adjusted to the elevation at Kindred and converted to the elevation at Horace using the 1969 water surface profile. In retrospect, this method seems rather poor. By Stage 3, detailed backwater computations had been done, and more accurate elevations at Horace were provided. This additional work resulted in a much different picture of flooding in reach 5-B for other historic events. If this were a primarily agricultural project, then a lower level water surface profile might be surveyed to check the sensitivity of the elevation-area flooded relationships. But because of the relatively low amount of agricultural damages in this reach compared to the urban-type damages, further refinement was not pursued.

OTHER AGRICULTURAL

Other agricultural damages have been increased using the change in agricultural prices paid index from October 1978 to October 1980 (979/761 = 1.286).

TRANSPORTATION

Transportation damages were updated using the change in the Engineering News Record's (ENR) construction index.

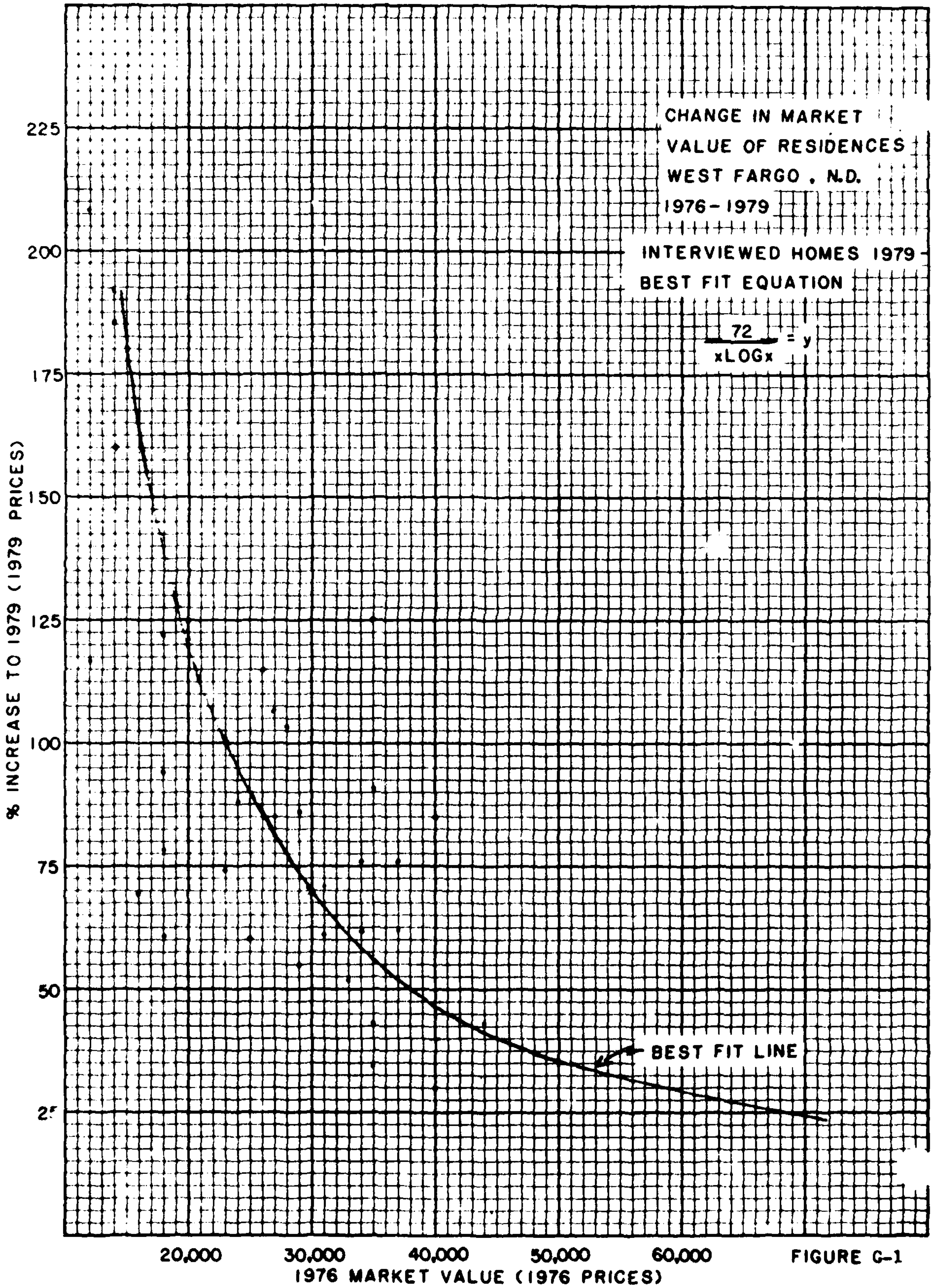
URBAN

Urban damages were divided into three categories: residential, commercial, and public. Data on damages in each dategory for specific floods were gathered over several years but primarily in 1976 and 1977. The data were updated to October 1978 prices using the ENR's building index to put all of the information on a common base for the Stage 2 report. This index is fairly representative for short-term updating. If no additional information has been received, this index, which increased by 34 percent from 1976 to 1980, would have been used again to update the base information to 1980 price levels. However, the depth-damage table sensitivity interviews conducted in West Fargo indicated that this index would understate the change in the market value of residential property.

Residents were asked during the depth-damage interviews to estimate the current (1979) market values of their homes. They estimated the values 30 to 368 percent higher than estimated by the assessors in 1976. The majority of the residents interviewed estimated a 60 to 90 percent increase. The local assessors and a local realtor confirmed that these estimates were accurate. The realtor provided actual selling prices for recent sales which showed similar increases from our 1976 estimates. The West Fargo city planner indicated at least a 15-percent annual increase for all structures.

Over the same period, the Fargo-Moorhead Board of Realtors recorded a 38 percent increase for all units sold. A spokesperson for the Board indicated that homes in the West Fargo area have probably appreciated at a greater rate because of a larger percentage of new homes and the desirability of West Fargo over other areas.

Figure G-1 illustrates the relationship between the 1976 market value of the residential structures and the percent increase to the 1979 market value estimated by the surveyed residents. The mean house value in 1976 was $30,000; the value increased 70 percent by 1979. The average 1979 market value was $51,000, somewhat less than the 1979 average selling value for the SMSA. High interest rates have decreased the rate of change in value for 1980 because demand has decreased. The index factor used to adjust urban residential damages in West Fargo to 1980 prices is 1.78.



CHANGE IN MARKET VALUE OF RESIDENCES WEST FARGO, N.D. 1976-1979
INTERVIEWED HOMES 1979
BEST FIT EQUATION
$\frac{72}{x\mathrm{LOG}x} = y$
BEST FIT LINE
225
200
175
150
125
100
75
50
25
% INCREASE TO 1979 (1979 PRICES)
20,000
30,000
40,000
50,000
60,000
1976 MARKET VALUE (1976 PRICES)

FIGURE G-1

A representative of the local board of realtors stated that the value of homes outside West Fargo has increased at a somewhat slower rate. The principal reason is that these homes are higher priced and their values tend to increase at a slower rate (note figure G-1). The board representative indicated that an appropriate increase for our time frame would be 50 percent. An index factor of 1.5 was used for all other residential.

HISTORIC FLOOD DAMAGES

Since 1945, at least eight major floods have occurred in the area. Each flood caused damages of over $1.5 million at the time of its occurrence. Since 1965, damages have been substantially reduced by emergency flood fights. The 1969 flood was a spring snowmelt flood that inundated 45,500 acres of farmland and small subdivisions downstream of Kindred. Total damages in that flood were $8.7 million. If there had been no flood fight, an estimated $5 million in additional damages would have occurred, primarily in West Fargo.

The most destructive flood on the lower Sheyenne River occurred in July 1975. An estimated 49,200 acres were flooded by overbank flow. Because the flood occurred late in the growing season, crops on all inundated acres were destroyed. Total damages in the basin for the 1975 flood, including runoff and rain damages, were $96.7 million.

In March 1978, an early spring flood caused extensive damage downstream of West Fargo. Harwood, some subdivisions, agricultural land, and transportation facilities in reaches 5-C, 5-D, and 5-E suffered damages totaling $3.4 million. Had the flood occurred later in the growing season, damages could have been substantially higher.

In late April 1979, a major flood on the Sheyenne River inundated cropland and threatened urban areas. Emergency protective measures prevented a major disaster. Sandbag dikes and emergency levees at Valley City, Lisbon, Horace, Harwood, West Fargo, and independent subdivisions prevented an estimated $54.5 million in urban and residential damages. About $37.8 million of the total was in West Fargo. Urban areas and subdivisions sustained damages (including flood fight costs) estimated at approximately $6.6 million. Agricultural and transportation damages along the Sheyenne River were estimated at $3.1 million.

EVALUATION OF FLOOD DAMAGES - PRESENT CONDITIONS

URBAN DAMAGES

In 1977, about 2,600 single-family residences were subject to flooding from the 100-year flood in the lower Sheyenne River basin (see table G-2). About 158 commercial buildings, 137 apartment units, and 44 public structures are also subject to flooding. The number of single-family residences in Valley City subject to flooding from the 100-year flood is about one-fourth the total in the lower Sheyenne River valley. A detailed breakdown by number and type of structures in the 100-year floodplain is shown in the future growth section.

Table G-2 - Structures subject to 100-year flooding - lower Sheyenne River valley, Valley City, and Lisbon, 1977

Location	Single-family residences	Multiple-family units	Commercial	Public	Total
Lower Sheyenne River valley	2,636	137	158	44	2,975
Valley City	625	-	67	0	692
Lisbon	161	-	3	2	166
Total	3,422	137	228	46	3,833

Estimates of residential flood damages were based on inspection of residences in the floodplain. The approximate market value of each residence inspected, ground and first-floor elevations as estimated with a hand level, and depths of flooding at each structure without emergency protective measures were determined. The without emergency protective measures condition was assumed to be the base condition. While past floods have been fought with varying degrees of success in many areas (see pages M-5 through M-7), the questionable structural integrity of the emergency levees (as discussed in Appendix M) makes the dependability of the levees uncertain. Estimates of flood damages to residences and contents were obtained from the standardized depth-damage tables developed in the St. Paul District. Field inspection of their appropriateness for the study area was done for a limited sample in West Fargo only (see sensitivity discussion on page G-60).

(R 3/83)

The market value of residences was verified by city assessors' records of a sample of homes. The estimates of flood damages to commercial and public properties at the selected flood elevations and discharges were obtained from interviews with property owners and public officials.

Table G-3 shows the damages for each base flood plus one or two deviations from the base flood profile.

Table G-3 - Urban flood damages (1977 conditions and October 1980 prices ($1,000)

Urban area or reach	Flood magnitude 3/	Discharge (cfs)	Recurrence frequency (%)	Flood elevation at reference point (ft)	Reference point	Urban flood damages: Residential	Commercial	Public	Total
Valley City	1966	3,000	12.0	1213.47 3/	Valley City gage	4,245	17	136	4,398
	1966 + 3 feet		2.6	1216.47		7,941	33	253	8,227
	1966 + 5 feet		1.8	1218.47		11,265	2,002	2,363	15,630
Lisbon	1966	4,260	9.5	1082.7	Lisbon gage	1,024	14	188	1,226
	1966 + 1 foot		6.5	1083.7		1,246	16	206	1,468
	1966 + 5 feet		0.9	1087.7		2,759	205	1,192	4,156
Horace	1897 - 4 feet 1/		34.0	911.9	Horace - staff gage	429	-	75	504
	1897 - 2 feet		20.0	913.9		779	-	137	916
	1897 2/	3,150	8.0	915.9		1,323	-	235	1,558
West Fargo	1965 - 2 feet 1/		32.0	895.97	USGS gage West Fargo	27,310	703	3	28,016
	1965	2,800	18.5	897.97		39,308	4,628	1,939	45,875
	1965 + 2 feet		3.0	899.97		50,051	7,080	2,643	59,774
Harwood, Brooktree, and Rivertree	1897 - 4 feet	-	19.5	892.5	Mouth of the Maple River	1,097	5	52	1,154
	1897 - 2 feet	-	11.5	894.5		1,856	33	127	2,016
	1897	-	6.0	896.5		2,636	122	153	2,911
Argusville	1897 - 4 feet	-	19.5	892.5	Mouth of the Maple River	73	3	36	112
	1897 - 2 feet	-	11.5	894.5		494	18	106	618
	1897	-	6.0	896.5		650	55	130	835
Gardner	1897 - 1 foot	-	11.5	894.5	Mouth of the Maple River	77	-	-	77
	1897	-	6.0	896.5		350	-	-	350
Reach 5-A (Kindred to Horace)	1897 - 2 feet		20.0	944.0	USGS Kindred gage	1,116	-	-	1,116
	1897	4,300	13.8	946.0		2,393	-	-	2,393
Reach 5-B (Horace to U.S. 94)	1897 - 2 feet	-	20.0	913.9	Horace - staff gage	2,100	-	-	2,100
	1897	4,300	8.0	915.9		3,529	-	-	3,529
Reach 5-D (U.S. 10 to U.S. 81)	1897 - 4 feet	-	19.5	892.5	Mouth of the Maple River	2,602	-	-	2,602
	1897 - 2 feet	-	11.5	894.5		4,030	-	-	4,030
	1897	-	6.0	896.5		5,050	-	-	5,050
Reach 5-E (I-29 to Red River of the North)	1897 - 4 feet	-	19.5	892.5	Mouth of the Maple River	713	-	-	713
	1897 - 2 feet	-	11.5	894.5		1,176	-	-	1,176
	1897	-	6.0	896.5		1,704	-	-	1,704

1/ A flood of this elevation would be below the natural levees. It is presented to illustrate the potential for substantial damages once the natural channel is exceeded.

2/ The same elevation because of the restricted channel now occurs at a Q of 3,150 cfs.

3/ The 1897 flood was used as the reference flood to define the study area. This flood is the largest well-documented event in the rural areas. High-water marks for this flood can be found in USDA bulletin No. 1017 published in March 1922.

The following information were used in the evaluation of damages.

Valley City and Lisbon

1. The zero damage point is lowest channel capacity determined by cross section.
2. The 1966 water surface profile is representative and was used for developing stage-damage relationships.
3. Noncertifiable emergency works can/will fail.
4. Sufficient volume exists for ponding to occur.
5. The economic, hydrologic, and hydraulic relationships can be found on plates G-2, G-3, C-2, and B-163 for Valley City and plates G-4, G-5, C-3, and B-163 for Lisbon.

Rural Subdivisions 5A-5B

1. Any discharge greater than 2,800 cfs (cubic feet per second) or with an elevation greater than 946.97 at Kindred has the potential to break out of the channel downstream.
2. Flows may break out upstream of a damage area, flow into coulees, and flow parallel to the river, inundating homes.
3. Once flows break out of the perched channel, the water will pond in depressions.
4. Noncertifiable emergency works can/will fail.
5. Sufficient volume exists for ponding to occur.
6. The economic, hydrologic, and hydraulic analysis is presented graphically in the following plates:

Subdivision	Elevation Damage	Elevation Frequency	Frequency Damage
5-A	G-16	B-21	G-17
5-B	G-18	(B-22, B-23, C-5)	G-19
5-D	G-20	B-29	G-21
5-E	G-22	B-29	G-23

1. Channel capacity through Horace is 2,100 cfs (the flow of the 1950 flood).
2. Noncertifiable emergency works will fail.
3. Sufficient volume exists for ponding.

4. Economic, hydrologic, and hydraulic information can be found on plates G-6, G-7, B-22, B-23, and C-5.

West Fargo

1. The natural channel is defined as that channel which held the 1950 peak flow. Emergency works were minimal and the river was bank-full.
2. Hydrologists have determined over bank-full begins at USGS (U.S. Geological Survey) gage elevation of 897.5, based on the 1950 flood.
3. No indirect damages are assumed. Soil permeability is low and the sewer system is sufficiently pressurized. Occasional stormwater ponding could be expected but is not relatively significant.
4. The 1965 water surface profile represents typical water surface profiles through town. See the sensitivity analysis on page G-59.
5. The Sheyenne River is a perched channel. Land next to the river is higher than surrounding land. Floodwaters would flow through town to pond in the low areas and drain out through the interior drainage system.
6. Low natural banks occur on each side of the river. Breakouts can occur on either bank.
7. Emergency levees are not certifiable for the following reasons:
   a. They have pervious shells and cores.
   b. Setback is insufficient; especially important on rivers that have double peaks.
   c. Added material has been placed over sod.

8. Volume is sufficient to cause ponding.

9. Economics, hydrologic and hydraulic information for West Fargo can be found on plates G-8, G-9, and B-26.

The profiles indicated on table G-3, the two variants of those profiles and the zero damage point on table G-1 were analysed and used to determine the elevation-damage relationships shown on the referenced plates. Damages for each event were evaluated at each structure, then aggregated to form the plot points. The

hydrology-hydraulics information used to convert this information into average annual damages are referenced above under each urban area. (Average annual flood damages for 1977 conditions are summarized in the following table.)

Table G-4 - Average annual urban damages (1977 conditions and October 1980 dollars)

Location	Average annual damages ($1,000)	Residential		Commercial		Public	
		Per-cent	Total ($1,000)	Per-cent	Total ($1,000)	Per-cent	Total ($1,000)
Valley City	1,350	94	1,269	2	27	4	54
Lisbon	270	81	219	1	3	18	48
Horace	329	90	296	-	-	10	33
West Fargo/ Riverside	13,405	84.3	11,310	11.4	1,524	4.3	571
Gardner	48	100	48	-	-	-	-
Argusville	183	86	157	5	9	9	17
Harwood	326	94	307	1	3	5	16
Rivertree	170	100	170				
Brooktree	58	100	58				
Nonurban 5-A	722	100	722				
Nonurban 5-B	707	100	707				
Nonurban 5-D	939	100	939				
Nonurban 5-E	308	100	308				
Total urban damages	18,815		16,510		1,566		739

AGRICULTURAL DAMAGES

The crop losses caused by flooding have been determined using the net losses sustained by farmers in their crop-raising programs. All major crops were considered to determine the total potential loss from floods occurring at any time during the growing season. The evaluation takes into account the reduction in yield resulting from late planting after a spring flood, re-planting costs when reseeding is possible, a partial or complete loss of crop from flooding during the growing or harvesting periods, and net increases or decreases in farm operating costs that result from flooding.

Discharge-Area Inundated Relationships

The areas inundated by the 1897, 1969, and 1975 floods on the lower Sheyenne River and the 1966 and 1969 floods on reaches 2-4 were delineated on USGS quadrangle and county maps. For each reach, the areas flooded and corresponding peak mean daily discharges or peak elevations, together with the estimated minimum channel capacities, served as a basis for developing discharge- or elevation-area flooded curves. These curves are shown on elevation-area flooded plates at the end of this appendix.

Flood damages begin when water escapes the channel or is prevented from entering the channel because of high flows. The appropriate hydrology was used to determine the average annual acres flooded for each reach. Average annual acres flooded are given in the following table.

Table G-5 - Average annual acres flooded

Reach	Location	Acres flooded (rounded to nearest 50)
Sheyenne River		
2	Baldhill Dam to Kathryn	400
3	Kathryn to Soo Line bridge west of National Grasslands	600
4	Soo Line bridge west of National Grasslands to 4 miles southwest of Cass County line	2,100
5A	4 miles southwest of Cass County line	1,500
5B	Horace to I-94 bridge	1,000
5C	I-94 bridge to West Fargo	550
5D	West Fargo to confluence of Maple River	8,100
5E	Confluence of Maple River to mouth	3,000

The following analysis of damages based on 1977 conditions and 1978 prices is presented for information only. Damages will be summarized at the end of this section in 1980 prices as described in the section on updating of damages.

Crop Prices

Because of wide fluctuations in crop prices caused by weather and other short-term circumstances, crop prices used in this report are based on normalized current prices as presented in the October 1978 Agricultural Price Standards developed by the U.S. Water Resources Council. Normalized prices for North Dakota and Minnesota are shown in table G-6.

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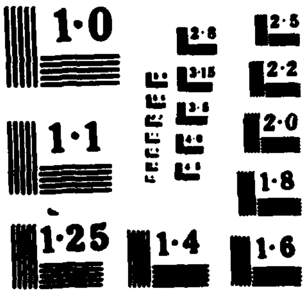
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Table G-6 - Crop prices, North Dakota and Minnesota

Crop	Current normalized price (CNP) North Dakota	Current normalized price (CNP) Minnesota
Wheat	$3.80 bu	$3.45 bu
Barley	2.47 bu	2.56 bu
Soybeans	5.86 bu	5.95 bu
Sunflowers	11.00 cwt (1)	11.00 cwt (1)
Corn	17.19 ton (2)	Not needed
Hay	41.54 ton	Not needed
Sugar beets	22.88 ton	23.66 ton

(1) Obtained from local elevators.
(2) Formula used by the University of Minnesota to estimate value of corn silage - (CNP) (2.36 x 6) + 3 = 17.19 for North Dakota.

Weighted Gross Crop Income

The weighted crop income for each acre in the floodplain, based on land use, must be derived before crop damages can be estimated. As indicated by table G-7, the unit price for each crop, when multiplied by the yield per acre and the land use expressed in percent, gives the weighted average crop income per acre over the entire floodplain area.[1] Also presented is the total weighted income per acre reflecting the combined values of all crops grown in the floodplain.

[1] e.g., Reach 2 corn

Percentage land use for corn (Table F-11)	1.3% of floodplain land I.E. .013
Yield per acre for corn (Table F-12)	6.6 tons/acre
Current normalized price for corn	x $17.19 /ton
Weighted gross income per acre (Table G-7)	$ 1.47 /acre

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Table G-7 - Weighted gross income per acre (October 1978 prices) (computation: 1978 normalized price x yield/acre x percent land use)

Crop	Unit	1978 current normalized price (1)	Reach 2	Reach 3	Reach 4	Reach 5A	Reach 5B	Reach 5C	Reach 5D	Reach 5E
Corn	Ton	$17.16 (3)	$1.47	$9.54	$11.68	$5.66	$11.33	$5.66	-	-
Wheat	Bushel	3.80	9.59	15.44	11.40	59.85	63.27	77.06	$86.64	$82.08
Oats	Bushel	1.39	2.02	6.85	6.72	-	-	-	-	-
Barley	Bushel	2.47	5.39	5.19	5.43	30.01	35.20	35.96	31.25	17.66
Flaxseed	Bushel	7.06	2.56	2.87	2.77	-	-	-	-	-
Hay	Ton	41.54	3.32	17.36	18.28	-	6.31	-	-	-
Sunflowers	Cwt	11.00 (2)	-	-	-	10.01	10.01	13.12	10.40	23.10
Sugar beets	Ton	22.88	-	-	-	-	-	-	-	-
Potatoes	Cwt	3.53	-	-	-	-	-	-	-	-
Soybeans	Bushel	5.86	-	-	-	-	-	3.16	9.49	17.58
Pasture	Ton	41.54	27.42	11.63	11.63	-	-	-	-	-
Total			51.77	68.88	67.91	119.62	126.12	134.96	137.78	140.42

(1) CNP for North Dakota.
(2) Obtained from Agway Elevator, Grandin, North Dakota.
(3) Formula given by University of Minnesota for estimating value of corn silage: (price/bushel x 6) + 3 = price/ton, ($2.36 x 6) + 3 = $17.16.

Crop Production Costs

Crop production costs accrue to the farmer as a result of land and property ownership and the raising of crops. Fixed and variable production costs constitute the total costs of crop production. However, the fixed production costs, which consist of taxes, interest, amortization costs, and overhead costs, are not appreciably affected by flooding because these costs accrue whether or not a farmer raises and harvests a crop. Thus, this analysis considers only the variable production costs associated with planting, raising, and harvesting crops. Variable production costs include cost of seed, soil preparation, planting, weed control, cultivation, harvesting, and transportation to market. These costs were obtained from the North Dakota extension service crop budgets. A schedule of normal farm operations was established and variable semimonthly production costs were determined. Table G-8 presents the variable semimonthly production costs which are considered reasonably representative for all damage reaches.

Table G-8 - Seasonal variable production costs per acre - reaches 2-4, 5A-5E (October 1978 prices)

Seasonal period	Reaches 2-4							Reaches					
	Wheat	Barley	Oats	Hay	Flax-seed	Corn (silage)	Sun-flowers	5A-5E Wheat	5A-5E Barley	5A-5E Soybeans	5A-5E Sunflowers	5A-5C Corn	5B Hay
To 31 Mar	$6.40	$8.86	$3.81	-	$0.88	-	-	$6.98	$8.99	-	-	-	-
1-15 Apr	6.40	7.24	7.42	-	1.48	-	$9.81	6.96	7.34	-	$9.81	-	-
16-30 Apr	4.82	2.52	7.42	$6.25	2.91	$13.43	13.94	5.25	2.55	-	13.94	$13.43	$6.25
1-15 May	6.22	3.83	5.98	6.25	2.80	10.34	5.72	6.77	3.88	$12.46	5.72	10.34	6.25
16-31 May	0.37	3.57	2.07	0.46	5.04	21.71	5.59	0.41	3.62	8.12	5.59	21.71	0.46
1-15 Jun	1.07	0.89	1.77	0.46	0.52	13.44	1.09	1.17	0.90	6.79	1.09	13.44	0.46
16-30 Jun	1.08	0.89	1.77	7.35	0.23	1.03	4.37	1.17	0.90	6.83	4.37	1.03	7.35
1-15 Jul	0.37	0.37	0.35	0.46	0.23	1.03	4.02	0.41	0.37	0.38	4.02	1.03	0.46
16-31 Jul	0.37	0.79	0.35	7.35	4.89	1.03	3.52	0.41	0.80	0.38	3.52	1.03	7.35
1-15 Aug	0.75	3.15	1.45	0.46	10.73	1.03	0.52	0.81	3.19	0.38	0.52	1.03	0.46
16-31 Aug	3.27	11.54	2.07	7.35	4.01	10.35	0.52	3.57	11.70	0.38	0.52	1[illegible].35	7.35
1-15 Sep	9.26	8.81	2.07	-	-	29.98	4.37	10.10	8.93	5.22	4.37	[illegible]9.98	-
16-30 Sep	6.36	-	1.13	-	-	-	5.21	6.93	-	5.22	5.21	-	-
1-15 Oct	-	-	0.35	-	-	-	1.90	-	-	-	1.90	-	-
16-31 Oct	-	-	-	-	-	-		-	-	-	-	-	-
Preharvest	27.82	28.17	30.94	14.34	14.12	62.02	49.10	30.30	28.56	35.72	49.10	62.02	14.34
Harvest	18.93	24.29	7.07	22.05	19.72	41.35	11.48	20.63	24.62	10.44	11.48	41.35	22.05
Total	46.75	52.46	38.01	36.39	33.84	103.37	60.58	50.93	53.18	46.16	60.58	103.37	36.39

The following table presents the net change in variable production costs caused by flooding. Some increases in production costs may be caused by soil reworking, refertilizing, application of additional fertilizer, or replanting. Variable costs may also decrease because the delay in planting may cause farmers to skip otherwise desirable operations. Yields reduced by flooding also decrease harvest expenditures for hauling and storage. Each crop has its own pattern of changes. The total change in the variable production cost per composite acre is weighted by the percent land use of each crop in the floodplain.

Table G-9 - Weighted net change in production costs - reaches 2-4, 5A-5E (October 1978 prices)

Seasonal period	Reach 2 Wheat	Reach 2 Barley	Reach 2 Corn	Reach 2 Flax-seed	Reach 2 Oats	Reach 2 Hay	Reach 2 Total	Reach 3 Wheat	Reach 3 Barley	Reach 3 Corn	Reach 3 Flax-seed	Reach 3 Oats	Reach 3 Hay	Reach 3 Total	Reach 4 Wheat	Reach 4 Barley	Reach 4 Corn	Reach 4 Flax-seed	Reach 4 Oats	Reach 4 Hay	Reach 4 Total
Percent land use (1)	8.7	5.9	1.3	3.3	3.3	6.0		12.5	5.0	5.4	2.8	9.3	22.0		[illegible]	[illegible]	5.4	1.8	9.1	11.0	
To 31 Mar	-0.16	-0.07	0	-0.02	0	0	-0.25	-0.17	-0.06	0	-0.02	0	0	-0.27	-0.11	-0.06	0	-0.02	0	0	-0.21
1-15 Apr	-0.17	-0.15	0	-0.12	0	0.19	-0.63	-0.26	-0.13	0	-0.11	-0.01	1.01	0.54	-0.19	[illegible]	0	-0.11	-0.01	1.01	0.59
16-30 Apr	-0.25	0.12	.03	-0.19	0.12	0.37	-0.20	-0.36	0.10	0.15	-0.16	0.34	2.06	[illegible]	0.29	[illegible]	0.16	-0.16	0.35	2.06	2.80
1-15 May	0.32	0.27	0.13	-0.20	0.26	-0.88	-0.12	0.47	0.23	0.54	-0.17	0.67	-4.85	-3.[illegible]	0.37	0.23	0.54	-0.17	0.67	-4.85	-3.21
16-31 May	0.26	.06	0.27	-0.19	0.22	-0.88	-0.28	0.35	0.05	1.16	-0.16	0.61	-4.85	-2.9[illegible]	0.28	0.05	1.16	-0.16	0.61	-4.85	-2.93
1-15 Jun	0.33	0.12	0.40	-0.22	0.32	-0.88	0.07	0.48	0.105	1.65	-0.19	0.90	-4.85	-1.90	0.38	0.11	1.65	-0.19	0.90	-4.85	-2.00
16-30 Jun	-1.65	-1.43	-0.36	-0.49	-0.15	-0.66	-4.92	-2.37	-1.22	-2.23	-0.41	-0.62	-3.66	-10.2[illegible]	-1.09	-1.21	-2.23	-0.41	-0.62	-3.66	-9.80
1-15 Jul	-1.65	-1.63	-0.36	-0.44	-0.17	-0.66	-4.89	-2.37	-1.22	-2.23	-0.37	-0.49	-3.66	-10.26	-1.09	-1.21	-2.23	-0.37	-0.49	-3.66	-9.81
16-31 Jul	-1.65	-0.80	-0.36	-0.36	-0.15	-0.60	-3.90	-1.16	-3.68	-2.23	-0.31	-0.63	-2.18	-8.20	-1.09	-0.60	-2.23	-0.31	-0.63	-2.18	-7.61
1-15 Aug	-0.79	-0.29	-0.36	-0.31	-0.13	-0.60	-2.46	-0.67	-3.26	-2.23	-0.26	-0.37	-2.18	-6.62	-0.91	-0.26	-2.23	-0.26	-0.37	-2.18	-6.19
16-31 Aug	-0.33		-0.46	-0.26	-0.11	-0.13	-1.27			-1.81	-0.22	-0.31	-0.73	-3.56	-0.38		-1.81	-0.22	-0.31	-0.73	-3.45
1-15 Sep			-0.18		-0.09		-0.27			-0.74		-0.26		-1.00			-0.74		-0.26		-1.00
16-30 Sep																					
1-15 Oct																					
16-31 Oct																					

Seasonal period	Reach 5A Wheat	Reach 5A Barley	Reach 5A Soybeans	Reach 5A Sun-flowers	Reach 5A Corn	Reach 5A Total	Reach 5B Wheat	Reach 5B Barley	Reach 5B Sun-flowers	Reach 5B Corn	Reach 5B Hay	Reach 5B Total
Percent land use (1)	45.0	27.0	13.0	7.0	3.0		45.0	30.0	7.0	6.0	4.0	
To 31 Mar	-.65	-.33				-.98	-.65	-.37				-1.02
1-15 Apr	-.95	-.71		.01		-1.65	-.95	-.79	.01		.16	-1.57
16-30 Apr	1.42	.57		.47	.09	2.55	1.42	.64	.47	.17	.32	3.02
1-15 May	1.83	1.26	.84	.98	.30	5.21	1.83	1.40	.98	.60	-1.46	3.35
16-31 May	1.36	.27	1.88	1.40	.63	5.46	1.36	.30	1.40	1.26	-1.46	2.86
1-15 Jun	1.87	.58	2.60	1.76	.91	7.52	1.87	.64	1.76	1.83	-1.46	4.64
16-30 Jun	-9.28	-6.65	-1.36	-.48	-1.24	-19.01	-9.28	-7.39	-.48	-2.48	-1.09	-20.72
1-15 Jul	-9.28	-6.65	-1.36	-.60	-1.24	-19.13	-9.28	-7.39	-.60	-2.48	-1.09	-20.84
16-31 Jul	-9.28	-3.72	-1.36	-.44	-1.24	-16.06	-9.28	-4.14	-.44	-2.48	-.66	-17.00
1-15 Aug	-6.46	-1.33	-1.36	-.34	-1.24	-8.73	-6.46	-1.48	-.34	-2.48	-.66	-9.42
16-31 Aug	-1.06		-1.36	-.32	-1.00	-4.54	-1.06		-.32	-2.01	-.22	-4.41
1-15 Sep			-.73	-.31	-.41	-1.65			-.31	-.82		-1.13
16-30 Sep			-.40	-.26		-.75			-.26			-.26
1-15 Oct												
16-31 Oct												

Seasonal period	Reach 5C Wheat	Reach 5C Barley	Reach 5C Soybeans	Reach 5C Sun-flowers	Reach 5C Corn	Reach 5C Total	Reach 5D Wheat	Reach 5D Barley	Reach 5D Soy-beans	Reach 5D Sun-flowers	Reach 5D Total	Reach 5E Wheat	Reach 5E Barley	Reach 5E Soy-beans	Reach 5E Sun-flowers	Reach 5E Total
Percent land use (1)	52.0	28.0	3.0	9.0	3.0		57.0	23	9.0	7.0		54.0	13.0	15.0	15.0	
To 31 Mar	-.75	-.36				-1.09	-.82	-.28			-1.10	-.78	-.16			-.94
1-15 Apr	-1.10	-.74		.01	-	-1.83	-1.21	-.60		.01	-1.80	-1.14	-.34		.01	-1.47
16-30 Apr	1.64	.59		.60	.09	2.92	1.80	.49		.47	2.76	1.70	.28		1.01	2.99
1-15 May	2.11	1.31	.19	1.26	.30	5.17	2.31	1.08	.58	.98	4.95	2.19	.61	.97	2.10	5.87
16-31 May	1.58	.28	.41	1.78	.63	4.68	1.73	.28	1.26	1.40	4.65	1.64	.13	2.07	2.97	6.81
1-15 Jun	2.16	.60	.55	2.26	.91	6.48	2.37	.49	1.66	1.76	6.28	2.25	.28	2.77	3.77	9.07
16-30 Jun	-10.73	-6.09	-.31	-.62	-1.24	-19.79	-11.76	-5.66	-.94	-.48	-18.84	-11.14	-3.20	-1.57	-1.03	-16.94
1-15 Jul	-10.73	-6.09	-.31	-.77	-1.24	-19.94	-11.76	-5.66	-.94	-.60	-18.96	-11.14	-3.20	-1.57	-1.29	-17.20
16-31 Jul	-10.73	-3.06	-.31	-.57	-1.24	-16.71	-11.76	-3.17	-.94	-.44	-16.31	-11.14	-1.79	-1.57	-.95	-15.45
1-15 Aug	-5.15	-1.38	-.31	-.43	-1.24	-8.51	-5.66	-1.13	-.94	-.34	-8.05	-5.35	-.64	-1.57	-.72	-8.28
16-31 Aug	-2.15		-.31	-.61	-1.00	-3.87	-2.35		-.94	-.32	-3.61	-2.23		-1.57	-.69	-4.49
1-15 Sep			-.17	-.38	-.41	-.97			-.51	-.31	-.82			-.85	-.65	-1.50
16-30 Sep			-.11	-.33		-.44			-.36	-.26	-.60			-.56	-.55	-1.11
1-15 Oct																
16-31 Oct																

Seasonal Loss of Gross Income per Acre

In addition to changes in production costs, farmers lose a share of gross income proportional to the reduced yield caused by flooding. The following table shows the weighted gross income loss per acre.

Table G-10 - Seasonal loss of gross income per acre - reaches 2-4, 5A-5E (October 1978 prices)
(computation: weighted gross income/acre x seasonal percent crop loss)

Seasonal period	Reach 2 Wheat	Barley	Corn	Flaxseed	Pasture	Oats	Hay	Total
To 31 March	.67	.27		.77	2.19			
1-15 April	1.15	.65		.49	2.19	[illegible]	.17	
16-30 April	1.92	1.13	.13	.90	2.19	.51	.33	
1-15 May	4.32	2.05	.22	1.18	3.29	.81	3.32	
16-31 May	4.79	2.86	.32	1.36	4.66	.97	3.32	
1-15 June	6.43	3.50	.59	1.66	6.03	1.07	3.32	
16-30 June	9.59	5.39	1.47	1.92	7.40	[illegible]	2.49	
1-15 July	9.59	5.39	1.47	1.72	6.31	[illegible]	2.49	
16-31 July	9.59	3.02	1.47	1.43	5.21	1.33	1.49	
1-15 Aug.	4.60	1.08	1.47	1.20	4.66	1.13	1.49	
16-31 Aug.	1.92		1.19	1.02	3.84	[illegible]	.50	
1-15 Sept.			.49		5.76	.81		
16-30 Sept.					7.68			
1-15 Oct.								
16-31 Oct.								

Seasonal period	Reach 3 Wheat	Barley	Corn	Flaxseed	Pasture	Oats	Hay	Total
To 31 March	1.08	.26		.09	.93	.34		2.70
1-15 April	1.85	.62		.55	.93	1.71	.87	6.53
16-30 April	3.09	1.09	.86	1.00	.93	2.74	1.74	11.45
1-15 May	6.95	1.97	1.43	1.32	1.40	3.29	17.36	33.72
16-31 May	7.72	2.75	2.10	1.52	1.98	3.63	17.36	37.06
1-15 June	10.34	3.37	3.82	1.87	2.56	4.38	17.36	43.70
16-30 June	15.44	5.19	9.54	2.15	3.14	5.14	13.02	53.62
1-15 July	15.44	5.19	9.54	1.92	2.67	4.52	13.02	52.30
16-31 July	15.44	2.91	9.54	1.61	2.21	3.84	7.81	43.36
1-15 Aug.	7.41	1.04	9.54	1.35	1.98	3.22	7.81	32.35
16-31 Aug.	3.09		7.73	1.15	1.63	2.74	2.60	18.94
1-15 Sept.			3.15		2.44			5.59
16-30 Sept.					3.26			3.26
1-15 Oct.								
16-31 Oct.								

Seasonal period	Reach 4 Wheat	Barley	Corn	Flaxseed	Pasture	Oats	Hay	Total
To 31 March	.80	.27		.08	.93	[illegible]		2.42
1-15 April	1.37	.65		.53	.93	[illegible]	[illegible]	6.07
16-30 April	2.28	1.14	1.05	.97	.93	2.69	[illegible]	10.89
1-15 May	5.13	2.06	1.75	1.27	1.40	[illegible]	[illegible]	33.12
16-31 May	5.70	2.88	2.57	1.47	1.98	[illegible]	[illegible]	[illegible]
1-15 June	7.64	3.53	4.67	1.80	2.56	[illegible]	18.28	[illegible]
16-30 June	11.40	5.43	11.68	2.08	3.14	[illegible]	13.71	[illegible]
1-15 July	11.40	5.43	11.68	1.86	2.67	[illegible]	13.71	[illegible]
16-31 July	11.40	3.04	11.68	1.55	2.21	[illegible]	[illegible]	[illegible]
1-15 Aug.	5.47	1.09	11.68	1.30	1.98	[illegible]	[illegible]	[illegible]
16-31 Aug.	2.28		9.46	1.11	1.63	[illegible]	[illegible]	[illegible]
1-15 Sept.			3.85		2.44			[illegible]
16-30 Sept.					3.26			[illegible]
1-15 Oct.								
16-31 Oct.								

Table G-10 - Seasonal loss of gross income per acre - reaches 2-4, 5A-5E (October 1978 prices)
(computation: weighted gross income/acre x seasonal percent crop loss) (cont)

Seasonal period	Reach 5A Wheat	Reach 5A Barley	Reach 5A Soybeans	Reach 5A Sun-flowers	Reach 5A Corn	Reach 5A Total	Reach 5B Wheat	Reach 5B Barley	Reach 5B Sunflowers	Reach 5B Corn	Reach 5B Hay	Reach 5B Total
1-31 March	$4.19	$1.50	$	$	$	$5.69	$4.43	$1.76	$	$	$	$[illegible]
1-15 April	7.18	3.60		.30		11.08	7.59	4.22	.30		.32	[illegible]
16-30 April	11.97	6.30		.90	.51	19.68	12.65	7.39	.90	1.02	.83	[illegible]
1-15 [illegible]	26.93	11.40	1.27	1.50	.85	41.95	28.47	13.38	1.50	1.70	6.[illegible]	[illegible]
16-31 [illegible]	29.93	15.91	1.41	2.50	1.25	51.00	31.64	18.66	2.50	2.49	6.31	[illegible]
1-[illegible]	41.10	19.51	3.80	4.00	2.26	69.67	42.39	22.88	4.00	4.53	6.31	[illegible]
16-3[illegible]	[illegible]	30.01	14.09	6.01	5.66	115.62	63.27	35.20	6.01	11.33	4.73	[illegible]
1-15 [illegible]	[illegible]4.85	30.01	14.09	7.51	5.66	117.12	63.27	35.20	7.51	11.33	4.73	[illegible]
16-[illegible]	[illegible]4.85	16.81	14.09	5.51	5.66	101.92	63.27	19.71	5.51	11.33	2.5[illegible]	[illegible]
[illegible]	[illegible]5.73	6.00	14.09	4.20	5.66	58.68	30.37	7.0[illegible]	4.20	11.33	2.34	[illegible]
16-[illegible]	11.97		14.09	4.00	4.58	34.64	12.65		4.00	9.15	.35	[illegible]
1-15 [illegible]			7.61	3.80	1.87	13.28			3.80	3.74		[illegible]
16-30 [illegible]			5.07	3.20		8.27			3.20			3.20
1-15 [illegible]				2.20		2.20			2.20			2.20
16-31 [illegible]												

Seasonal period	Reach 5C Wheat	Reach 5C Barley	Reach 5C Soy-beans	Reach 5C Sun-flowers	Reach 5C Corn	Reach 5C Total	Reach 5D Wheat	Reach 5D Barley	Reach 5D Soybeans	Reach 5D Sun-flowers	Reach 5D Total	Reach 5E Wheat	Reach 5E Barley	Reach 5E Soybeans	Reach 5E Sun-flowers	Reach 5E Total
[illegible]	$5.39	$[illegible]	$	$	$	$7.19	$6.06	$1.56	$	$	$7.62	$5.75	$ .88	$	$	$ 6.63
[illegible]	9.25	[illegible].32		.39		13.96	10.40	3.75		.31	14.46	[illegible]	2.12		[illegible]	[illegible]
[illegible]	15.4[illegible]	[illegible]		1.18	.51	[illegible].65	17.33	6.56		.94	24.83	[illegible].42	3.71		[illegible]	22.21
[illegible]	[illegible]	13.66	.28	1.97	.85	51.44	38.99	11.88	.85	1.56	53.28	[illegible]	6.71	1.58	3.[illegible]	[illegible]8.69
[illegible]	36.33	19.[illegible]	.32	3.28	1.25	62.44	43.32	11.56	.95	2.60	63.43	[illegible]	9.36	1.76	5.[illegible]	57.94
[illegible]	51.63	[illegible]	.85	5.25	2.26	83.36	58.05	20.31	2.56	4.16	84.98	[illegible]	11.48	4.75	9.[illegible]	80.46
[illegible]	77.06	[illegible]	3.16	7.87	5.66	129.71	86.64	31.25	9.49	6.24	133.62	82.08	17.66	17.58	13.[illegible]	131.18
[illegible]	77.06	[illegible]	3.16	9.84	5.66	131.68	86.64	31.25	9.49	7.80	135.18	82.08	17.66	17.58	17.[illegible]	134.64
[illegible]	77.06	[illegible]	3.16	7.22	5.66	113.24	86.64	17.50	9.49	5.72	119.35	82.08	9.89	17.58	12.[illegible]	122.25
[illegible]	36.99	[illegible].19	3.16	5.51	5.66	[illegible]8.51	41.59	6.25	9.49	4.37	61.70	[illegible]	3.53	17.58	[illegible]	[illegible]
[illegible]	15.41		3.16	5.25	4.58	[illegible]8.40	17.33		9.49	4.16	30.98	[illegible]		17.58	[illegible]	43.24
[illegible]			1.71	4.99	1.87	8.57			5.12	3.95	9.07			9.4[illegible]	[illegible]	18.[illegible]
[illegible]			1.14	4.20		5.34			3.42	3.33	6.75			6.3[illegible]	[illegible]	11.[illegible]
[illegible]				2.89		2.89				2.29	2.29				[illegible]	[illegible].08
16-3[illegible]																

Seasonal Crop Damage Curves

Total crop damages for each month consist of the loss of net income, which is equivalent to the total weighted investment losses or gains (forgone investments), combined with the loss of gross crop revenue for all crops grown in the floodplain.(1) On this basis, the weighted net change in production costs and weighted average loss of gross crop revenues for monthly periods are added to produce seasonal crop damages as indicated in table G-11. These crop damage totals are plotted to produce a seasonal crop damage curve for each reach.

(1) e.g., Reach 2 to 31 March:

SLGF		WNCP		SCD
3.90	+	-.25	=	3.65

Table G-11 - Seasonal crop damage per acre - reaches 2-4, 5A-5E (October 1978 prices)

Seasonal period	Reach 2			Reach 3			Reach 4		
	SLGI[1]	WNCPC[2]	SCD[3]	SLGI[1]	WNCPC[2]	SCD[3]	SLGI[1]	WNCPC[2]	SCD[3]
To 31 Mar	3.90	-0.25	3.65	2.70	-0.25	2.45	2.42	-0.21	2.21
1 15 Apr	4.75	-0.63	4.12	6.53	0.54	7.07	6.07	0.59	6.66
16-30 Apr	7.11	-0.20	6.91	11.45	2.13	13.58	10.89	2.80	13.69
1-15 May	15.19	-0.12	15.07	33.72	-3.11	30.61	33.12	-3.21	29.91
16-31 May	18.28	-0.28	18.00	37.06	-2.96	34.10	36.44	-2.93	33.51
1-15 Jun	22.60	0.07	22.67	43.70	-1.90	41.80	42.78	-2.09	34.46
16-30 Jun	29.55	-4.92	24.63	53.62	-10.29	43.33	52.48	-9.80	42.68
1-15 Jul	28.48	-4.89	23.59	52.30	-10.26	42.04	51.19	-9.83	41.36
16-31 Jul	23.54	-3.90	19.64	43.36	-8.20	35.16	41.87	-7.41	34.46
1-15 Aug	15.63	-2.46	13.17	32.35	-6.42	25.93	32.91	-6.19	26.72
16-31 Aug	9.42	-1.27	8.15	18.94	-3.54	15.40	19.91	-3.45	16.46
1-15 Sep	7.06	-0.27	6.79	5.59	-1.00	4.59	6.29	-1.00	5.29
16-30 Sep	7.68		7.68	3.26		3.26	3.26		3.26
1-15 Oct									
16-31 Oct									

Table G-11 - Seasonal crop damage per acre - reaches 2-4, 5A-5E (October 1978 prices)(cont)

Seasonal period	Reach 5A SLGI (1)	5A WNCPC (2)	5A SCD (3)	5B SLGI (1)	5B WNCPC (2)	5B SCD (3)	5C SLGI (1)	5C WNCPC (2)	5C SCD (3)	5D SLGI (1)	5D WNCPC (2)	5D SCD (3)	5E SLGI (1)	5E WNCPC (2)	5E SCD (3)
To 31 Mar (23 Mar)	5.69	-0.98	4.71	6.19	-1.02	5.17	7.19	-1.09	6.10	7.62	-1.10	6.52	6.63	-0.94	5.69
1-15 Apr (8 Apr)	11.08	-1.65	9.43	12.43	-1.57	10.86	13.96	-1.83	12.13	14.46	-1.80	12.66	12.66	-1.47	11.19
16-30 Apr (23 Apr)	19.68	2.55	22.23	22.59	3.02	25.61	24.65	2.92	27.57	24.83	2.76	27.59	22.21	2.99	25.20
1-15 May (8 May)	41.95	5.21	47.16	51.36	3.35	54.71	51.44	5.17	56.61	53.28	4.95	58.23	48.69	5.87	54.56
16-31 May (23 May)	51.00	5.46	56.46	61.60	2.86	64.46	62.44	4.68	67.12	63.43	4.65	68.08	57.94	6.81	64.75
1-15 Jun (8 Jun)	69.67	7.52	77.19	80.11	4.64	84.75	83.36	6.48	89.84	84.98	6.28	91.26	80.46	9.07	89.53
16-30 Jun (23 Jun)	115.62	-19.01	96.61	120.54	-20.72	99.82	129.71	-19.79	109.92	113.62	-18.84	94.78	131.18	-16.94	114.24
1-15 Jul (8 Jul)	117.12	-19.13	97.99	122.04	-20.84	101.20	131.68	-19.94	111.74	135.18	-18.96	116.22	134.64	-17.20	117.44
16-31 Jul (23 Jul)	101.92	-16.04	85.88	102.66	-17.00	85.66	113.24	-16.71	96.53	119.35	-16.31	103.04	122.25	-15.45	106.80
1-15 Aug (8 Aug)	58.68	-8.73	49.95	55.78	-9.42	46.36	58.51	-8.51	50.00	61.70	-8.05	53.65	70.21	-8.28	61.93
16-31 Aug (23 Aug)	34.64	-4.54	30.10	26.78	-4.41	22.37	28.40	-3.87	24.53	30.98	-3.61	27.37	43.24	-4.49	38.75
1-15 Sep (8 Sep)	13.28	-1.45	11.83	7.54	-1.13	6.41	8.57	-0.97	7.60	9.07	-0.82	8.25	18.27	-1.50	16.77
16-30 Sep (23 Sep)	8.27	-0.75	7.52	3.20	-0.26	2.94	5.34	-0.44	4.90	[illegible]	0	6.15	13.72	-1.11	12.61
1-15 Oct (8 Oct)	2.20		2.20	3.20		3.20	2.89		2.89	2.29		2.29	5.08		5.08
16-31 Oct															

(1) Seasonal loss of gross income per acre.
(2) Weighted net change in production costs.
(3) Seasonal crop damage.

Weighted Average Crop Damages per Acre

As indicated by the preceding analysis, the amount of crop damage depends on when a flood occurs. Thus, weighted average crop damages per acre of floodplain area based on the flood history must be determined. The historic events are assumed to be representative of Sheyenne River flooding. Table G-12 illustrates the derivation of the weighted average crop damage per acre for each reach.

G-12 - Average annual damages per acre

Reach	Date of flood	Peak mean daily discharge (cfs)(3)	Acres flooded	Crop damage per acre	Crop damage per flood	
2	2 Apr 48	1,900	300	$4.00	$1,200	
	19 May 50	3,030	1,220	17.50	21,300	
	28 Apr 56	1,790	180	10.50	1,900	
	17 Apr 60	1,570	50	5.50	300	
	17 Apr 65	3,070	1,230	5.50	6,800	
	30 Mar 66	3,330	1,650	3.50	5,800	
	19 Apr 69	4,500	2,300	6.00	13,800	
	21 Apr 71	1,810	220	6.50	1,400	
	23 Apr 74	2,160	500	7.50	3,700	
	29-30 Apr 75	1,850	230	11.50	2,600	
Total			7,900		58,800	
Average annual damages per acre						7.44
3	16 May 50	6,397	4,050	32.00	129,600	
	19 Apr 56	2,719	640	11.50	7,400	
	19 Apr 60	2,283	120	11.50	1,400	
	7 Jul 62	2,400	190	42.00	8,000	
	14 Apr 6[illegible]	3,280	1,200	9.50	11,400	
	15 Mar 66	3,350	1,220	2.50	3,100	
	30 Mar 66	3,950	1,840	4.50	8,300	
	24 Apr 69	4,360	2,300	16.00	36,800	
	1 Jul 75	5,210	2,880	43.00	123,800	
Total			14,400		329,800	
Average annual damages per acre						22.90
4	18 Apr 47	2,300	2,400	$10.00	$24,000	
	7 May 48	2,150	1,900	29.00	55,100	
	14 May 50	3,210	4,880	31.00	151,300	
	8 Apr 52	2,240	2,100	7.00	12,700	
	13 Apr 60	1,820	520	8.00	4,200	
	11 Jul 62	2,310	2,220	39.50	87,700	
	18 Apr 65	2,740	3,580	10.00	35,800	
	3 Apr 66	3,340	5,180	5.50	28,500	
	15 Apr 69	4,600	8,140	9.00	73,300	
	30 Apr 71	1,740	40	25.00	1,000	
	29 Apr 74	1,930	1,360	24.00	32,600	
	5 May 75	1,840	140	28.00	3,900	
	6 Jul 75	4,590	8,100	41.00	328,200(2)	
Total			40,560		840,300	
Average annual damages per acre						20.70

Table G-12 - Average annual damages per acre (Cont)

Reach	Date of flood	Peak mean daily discharge (cfs)(3)	Acres flooded	Crop damage per acre	Crop damage per flood	
5A	18 Apr 47	2,300	570	$18.00	$10,300	
	7 May 48	2,150	420	46.00	19,300	
	14 May 50	3,210	1,780	50.00	89,000	
	8 Apr 52	2,240	520	9.00	4,700	
	13 Apr 60	1,820	190	13.00	2,500	
	11 Jul 62	2,310	570	97.00	55,300	
	18 Apr 65	2,740	1,050	18.00	18,900	
	3 Apr 66	3,340	7,200	7.00	15,400	
	15 Apr 69	4,600	7,370	15.00	110,500	
	30 Apr 71	1,740	160	33.00	5,300	
	29 Apr 74	1,930	280	31.00	8,700	
	5 May 75(1)	1,840	210	43.00	9,000	
	6 Jul 75	4,590	7,970	98.00	772,000	
Total			23,290		1,120,900	
Average annual damage/acre						48.13
5B	18 Apr 47	2,300	280	19.00	5,300	
	7 May 48	2,150	210	54.00	11,300	
	14 May 50	3,210	870	58.00	50,500	
	8 Apr 52	2,240	250	11.00	2,700	
	13 Apr 60	1,820	90	15.00	1,300	
	11 Jul 62	2,310	280	99.00	27,700	
	18 Apr 65	2,740	510	19.00	9,700	
	3 Apr 66	3,340	1,070	8.00	8,600	
	15 Apr 69	4,600	3,590	16.00	57,400	
	30 Apr 71	1,740	80	45.00	3,600	
	29 Apr 74	1,930	130	43.00	5,600	
	5 May 75(1)	1,840	100	52.00	5,200	
	6 Jul 75	4,590	3,890	101.00	387,700	
Total			11,350		576,600	
Average annual damage/acre						50.80
5C	18 Apr 47	2,300	100	21.00	2,100	
	7 May 48	2,150	80	55.00	4,400	
	14 May 50	3,210	320	59.00	18,900	
	8 Apr 52	2,240	90	12.00	1,100	
	13 Apr 60	1,820	30	16.00	500	
	11 Jul 62	2,310	100	109.00	10,900	
	18 Apr 65	2,740	190	21.00	4,000	
	3 Apr 66	3,340	390	10.00	3,900	
	15 Apr 69	4,600	1,320	18.00	23,800	
	30 Apr 71	1,740	30	45.00	1,300	
	29 Apr 74	1,930	50	44.00	2,200	
	5 May 75(1)	1,840	40	52.00	2,100	
	6 Jul 75	4,590	1,430	111.00	156,700	
Total			4,170		231,900	
Average annual damage/acre						55.61

Table G-12 - Average annual damages per acre (cont)

Reach	Date of flood	Peak mean daily discharge (cfs) (3)	Acres flooded	Crop damage per acre	Crop damage per flood	
5D	18 Apr 47	2,300	1,910	$22.00	42,000	
	7 May 48	2,150	1,420	56.00	79,500	
	14 May 50	3,210	5,990	63.00	377,400	
	8 Apr 52	2,240	1,740	12.00	20,900	
	13 Apr 60	1,820	650	17.00	11,100	
	11 Jul 62	2,310	1,910	116.00	221,600	
	18 Apr 65	2,740	3,540	22.00	77,900	
	3 Apr 66	3,340	7,410	10.00	74,100	
	15 Apr 69	4,600	24,800	19.00	471,200	
	30 Apr 71	1,740	550	39.00	21,500	
	29 Apr 74 (1)	1,930	930	37.00	34,400	
	5 May 75	1,840	710	51.00	36,200	
	6 Jul 75	4,590	26,800	116.00	3,072,600	
Total			78,360		4,540,400	
Average annual damage/acre						57.94
5E	18 Apr 47	2,300	650	21.00	13,700	
	7 May 48	2,150	480	53.00	25,400	
	14 May 50	3,210	2,030	58.00	117,700	
	8 Apr 52	2,240	590	12.00	7,100	
	13 Apr 60	1,820	220	16.00	3,500	
	11 Jul 62	2,310	650	116.00	75,400	
	18 Apr 65	2,740	1,200	20.00	24,000	
	3 Apr 66	3,340	2,520	10.00	25,200	
	15 Apr 69	4,600	8,420	18.00	151,600	
	30 Apr 71	1,740	190	45.00	8,500	
	29 Apr 74 (1)	1,930	310	43.00	13,300	
	5 May 75	1,840	240	51.00	12,200	
	6 Jul 75	4,590	9,100	117.00	1,052,500	
Total			26,600		1,530,100	
Average annual damage/acre						57.52

(1) This total has been adjusted to account for the effects of a multiple-peak flood.
(2) The damage per flood figure has been adjusted to account for two independent floods in the same year.
(3) Discharge at Kindred-area flooded is estimated from profiles.

OTHER AGRICULTURAL DAMAGES

Other agricultural flood damages evaluated for this report include property damage to fences, buildings other than homes, machinery, stored crops, and other supplies; losses in dairy and beef production; and losses from erosion and sedimentation. The rural developments in most of the agricultural damage reaches are distributed rather uniformly over the floodplain. Total other agricultural property damages are approximately proportional to the area flooded. Data on these damages were obtained during 1975 in conjunction with a field damage survey within the Sheyenne River basin. Total other agricultural damages for all interviewed farmsteads for the 1975 flood were divided by the acres flooded for these farmsteads. All interviewed farmers thought that these damages would not vary by season. On the basis of these data, other agricultural property damages are estimated at $12.11 per acre for reaches 5A, B, C, D, and E. Survey information for reaches 2-4 was gathered in 1965 and updated for prices. Damages in these reaches were less than those in reach 5 because of the narrowness of the floodplain in the upper reaches. Farmers could move most of the damageable property to low risk areas. Other agricultural flood damages per acre flooded are summarized for each damage reach in table G-13.

Table G-13 - Other agricultural damages per acre (October 1978 prices)

Reach	Damage per acre flooded
2	$3.41
3	6.10
4	5.45
5	12.11

UPDATE TO 1980 PRICES

As noted previously, two sample reaches were selected to represent the changed price levels from 1978. The seasonal crop damage information for reaches 5-B and 5-D is summarized below.

Table G-14 -
Weighted seasonal crop damage - sample reaches 5-B and 5-D

Seasonal period	Seasonal crop damage	
	Reach 5-B	Reach 5-D
31 March (23 March)	$2.99	$3.61
1-15 April	12.16	13.60
16-30 April	20.26	21.46
1-15 May	52.78	53.17
16-31 May	75.61	80.64
1-15 June	63.28	66.48
16-30 June	79.22	93.35
1-15 July	80.31	94.80
16-31 July	67.77	84.23
1-15 August	36.66	44.94
16-31 August	17.57	24.15
1-15 September	4.44	8.21
16-30 September	2.98	6.11
1-15 October	2.05	2.13

Table G-15 combines the above information with the flood history.

Table G-15 - Average annual crop damages per acre - sample reaches

Reach	Date of flood	Elevation (feet msl)	Acres flooded	Crop damage per acre	Crop damage per flood
5B	18 Apr 47	914.2	2,600	$18.20	$47,320
	7 May 48	913.9	2,460	52.80	129,888
	14 May 50	915.0	3,280	63.40	207,952
	8 Apr 52	914.1	2,590	12.80	33,152
	13 Apr 60	912.5	1,700	15.50	26,350
	11 Jul 62	914.2	2,600	77.20	200,720
	8 Apr 65	915.23	3,440	12.80	44,032
	3 Apr 66	915.22	3,420	6.70	22,914
	15 Apr 69	915.4	3,600	16.60	59,760
	30 Apr 71	912.3	1,590	38.00	60,420
	29 Apr 74	913.1	1,990	38.50	70,645
	5 May 75	912.5	1,700	48.50	82,450
	6 Jul 75	915.47	3,890	64.10	140,379
	28 Mar 78	913.02	1,960	2.99	5,860
	7 May 79	915.85	5,340	52.80	281,952
Total			42,160		1,413,794
Average annual damage/acre				$33.53	
5D	18 Apr 47	897.72	13,500	19.10	257,850
	7 May 48	895.65	3,600	53.20	191,520
	14 May 50	897.80	13,700	65.80	901,460
	8 Apr 52	897.69	13,450	13.60	182,920
	11 Jul 62	896.21	4,400	91.90	404,360
	18 Apr 65	897.99	15,000	19.10	286,500
	3 Apr 66	898.23	17,500	7.60	133,000
	15 Apr 69	899.02	25,100	17.50	439,250
	6 Jul 75	899.44	29,000	94.80	2,749,200
	29 Mar 78	898.23	17,500	3.61	63,175
	21 Apr 79	899.31	28,200	20.80	586,560
Total			180,950		6,195,795
Average annual damage/acre				34.24	

Using the same proportions for the other reaches gives the following weighted damages per acre.

G-16 - Average annual crop damages per acre

Reach	October 1978 prices and flood history	October 1980 prices and flood history
2	$7.44	$4.91
3	22.90	15.11
4	20.72	13.68
5A	48.13	31.77
5B	50.80	33.53
5C	55.61	36.70
5D	57.94	34.24
5E	57.52	33.94

Other agricultural prices for October 1980 are shown below.

Table G-17 - Average annual other agricultural damages per acre

Reach	October 1978 prices	October 1980 prices
2	$3.41	$4.39
3	6.10	7.85
4	5.45	7.01
5 (A,B,C,D,E)	12.11	15.58

AVERAGE ANNUAL AGRICULTURAL AND OTHER AGRICULTURAL DAMAGES

The mean daily discharge-frequency or elevation-frequency relationships were combined to determine the frequency-area flooded. The average annual are flooded has been determined for each damage reach by integrating the area under the curve. The weighted average crop damages per acre flooded and the other agricultural damages per acre flooded multiplied by the annual area flooded figures indicate the total damages for each reach as shown in the following table.

Table G-18 - Average annual agricultural damages

Reach		Acres flooded	Damage per acre	Average annual damages
2	Crop	400	$4.91	$1,960
	Other agricultural		4.39	1,760
3	Crop	600	15.11	9,070
	Other agricultural		7.85	4,710
4	Crop	2,100	13.68	28,730
	Other agricultural		7.01	14,720
5A	Crop	1,500	31.77	47,660
	Other agricultural		15.58	23,370
5B	Crop	1,000	33.53	33.530
	Other agricultural		15.58	15,580
5C	Crop	550	36.70	20,190
	Other agricultural		15.58	8,570
5D	Crop	8,100	34.24	277,340
	Other agricultural		15.58	126,200
5E	Crop	3,000	33.94	101,820
	Other agricultural		15.58	48,740

TRANSPORTATION DAMAGES

The agricultural nature of the area is reflected in its road system. The majority of the roads are gravel section-line roads which tie into major blacktop highways at moderate intervals. Because of the frequency of flooding, most of the roads are elevated above the flood levels. Flood damages to the road system consist mostly of bridge approach washouts, culvert washouts, and shoulder scouring. Floods also damage railroads, airports, and waterways. Prior flood damage surveys were used to estimate the damages to these systems. Elevation- or discharge-damage curves for transportation are found on plates G-44 through G-51. Average annual transportation damages are shown in the following table.

Table G-19 - Average annual transportation damages (October 1980 prices)

Reach	Damages
2	$38,000
3	39,000
4	29,000
5	77,000

EVALUATION PERIOD

Benefits from proposed improvements would be realized beginning in 1990, the assumed year of project completion. For this economic analysis, an economic life of 100 years has been assumed. However, many uncertainties preclude reliable prediction of economic development 100 years in the future. Thus, economic growth was estimated only to the year 2040 (the first 50 years of project life). No growth is estimated after 50 years.

EVALUATION OF FLOOD DAMAGES - FUTURE CONDITIONS

URP

New Growth

New structures located in the floodplain are assumed to be flood proofed to at least the 1-percent chance flood level. Insufficient data are available to project flood damages for most of the study area. However, educated estimates can be made for West Fargo. Future damages to new development for West Fargo are summarized below.

Residential - Damages to residential structures would account for only a small fraction of future damages. The only reliable data for projecting new future development are for West Fargo. An analysis of new flood proofed residential construction in West Fargo between 1978 and 1980 follows.

Table G-20 - Expected average annual damages to flood proofed residences constructed in West Fargo in 1978, 1979, and 1980

Average value of new construction (Fargo-Moorhead Board of Realtors)	$68,000
100-year flood elevation for flood insurance purposes at Highways 10 and 52	901.8
Adjusted to USGS gage site for comparison with hydrology using 1969 profile	900.3
Elevation of ground around homes (referred to gage site)	900.5
Assume first-floor elevation (homes have basements)	901.3

Damages

Frequency (in percent)	Gage elevation	Depth of flooding	Damage
2.2 (1% for flood insurance)	900.3	0	0
1.2	900.8	0	0
1.0	901.2	7.9 foot basement	$20,700
0.5	902.0	0.7-foot first floor	29,600
0.2	903.0	1.7-foot first floor	33,000
Average annual damages	$300		

The following is a breakdown of the building permits issued for the 3 years and the damages to each unit.

Table G-21 - Average annual damages, new residential construction, West Fargo (damages are proportioned to value)

	Permits			Damages			
Year	Single family	Multi-family (1)	Duplex (2)	Single family	Multi-family (4)	Duplex	Total damages
1978	140	(136 units)	23	$42,000	$10,200	$9,700	$61,900 (3)
1979	53	5 (52 units)	9	15,900	3,900	3,800	23,600
1980	38	12 (60 units)	5	11,400	3,000	2,100	16,500
Total	231	248 units	37	69,300	17,100	15,600	102,000

(1) Multifamily units are estimated at 50 percent of the value of single family units by the city assessor.
(2) Duplexes are estimated by the city planner to cost 70 percent of single family price.
(3) No specific breakdown available; number of structures proportional to the 1979 figure.
(4) Most of the apartment construction is for 3-story buildings. It is estimated that only one-third of the units would be subject to flooding.

Total average annual damages to the flood proofed development is $102,000. This is less than 1 percent of the total average annual residential damages found in table G-4 for West Fargo. On the basis of this information, it is projected that new growth would follow a pattern. From 1978 to 1980, population for West Fargo increased by 1,632 persons (10,080 - 8,448 special census count). From 1980 to 2000 it is projected to increase by 5,420 (15,500 - 10,080) (table F-2 - Appendix F). Assuming that the demand for housing is proportional to the change in population, damages could increase by 3.8 percent as a result of new flood proofed residential construction in the floodplain by 2000:

$$\frac{5.420 \text{ persons}}{1,632 \text{ persons}} \quad P \quad \frac{X}{\$102,000 \text{ damages}}$$

$$x = \$339.000$$

$$\Delta \text{ in damages 1978 to 2000} = 102,000 + 339,000 = 441,000$$

By the year 2040, damages could have increased by 9 percent or $1,020,000 based on the projected population. Projected increases in damages to new development by decade are shown in table G-22.

Table G-22 - Changes in average annual damages resulting from new residential construction at West Fargo (October 1980 prices) (1)

	1978	1980	1990	2000	2010	2020	2030	2040
Total damage	0	$102,000	$284,500	$441,000	$584,500	$734,500	$941,000	$1,122,000
Increases from the previous decade	0	102,000	182,500	156,500	143,500	150,000	206,500	181,000

(1) Does not include growth to contents damage once structures are in place.

Table G-22A - Changes in number of units

1978	1980	1990	2000	2010	2020	2030	2040
Number at new residential units (1)							
0	553	1,543	2,391	3,170	3,984	5,102	6,085
Units subject to flooding (2)							
0	382	1,065	1,650	2,187	2,750	3,520	4,199

(1) Based on 1977 to 1980 density of 2.95 persons per unit.
(2) Two-thirds of multi units are above flood level.

Average annual equivalent damages for new residential growth are shown in the following table.

Table G-23 - Average annual residential damages for new growth after 1977 (1)(2)(3)

Time period	Growth to new residences constructed 1980	1990	2000	2010	2020	2030	2040	Changes in damages (1990 to 2040 or earliest year)	Average annual equivalent factor	Average annual equivalent of change	Total average annual equivalent damages in the decade units were added	Total damages for the life of the project (4)	Present worth factor	Present worth of total damages	Total average annual damages (5)
1977-1980															
Structure	$61,000	$61,000	$61,000	$61,000	$61,000	$61,000 (6)	$61,000	$69,000	0.3506 (7)	$24,000	$138,000		1.000		$138,000
Contents	41,000	53,000	69,000	89,000	116,000	122,000	122,000								
1980-1990															
Structure		109,500	109,500	109,500	109,500	109,500	109,500 (6)	122,000	0.2725 (8)	33,000	215,500		1.000		216,000
Contents		73,000	95,000	123,000	159,000	206,000	217,000								
1990-2000															
Structure			93,500	93,500	93,500	93,500	93,500	115,000	0.2853 (9)	33,000	189,500	2,482,000	0.4796	$1,190,000	91,000
Contents			63,000	82,000	106,000	137,000	178,000								
2000-2010															
Structure				86,500	86,500	86,500	86,500	67,000	0.3690 (10)	25,000	168,500	2,204,000	0.2300	507,000	39,000
Contents				57,000	74,000	96,000	124,000								
2010-2020															
Structure					90,000	90,000	90,000	41,000	0.4971 (11)	20,000	170,000	2,216,000	0.1103	244,000	19,000
Contents					60,000	78,000	101,000								
2020-2030															
Structure						123,500	123,500	25,000	0.7008 (12)	18,000	224,500	2,908,000	0.0529	154,000	12,000
Contents						83,000	108,000								
2030-2040															
Structure							109,000	0	-	-	181,000 (13)	2,314,000	0.0254	59,000	4,000
Contents							72,000								
Total	102,000	296,500	491,000	701,500	955,500	1,286,000	1,595,000	439,000		153,000	-	-	-	-	519,000

(1) See Appendix F for write-up.
(2) October 1980 dollars, 7 5/8-percent interest rate.
(3) The following assumptions were made regarding damages to new growth:
- Content damage is 40 percent of damages.
- Current content value is 25 percent of the value of the structure and may increase by a factor of 3. Maximum growth will be reached 42 years after the house is built (see table G-16). The growth rate is 2 5/8 percent compound.

(4) Total damages are equal to the average annual equivalent damages divided by the interest and amortization factor for the project life listed in footnotes 9 through 12.
(5) Interest and amortization factor for 100 years = 0.07630.
(6) There is only 2 years' growth from the previous decade. Growth stops in year 2022 and 2032 for homes built between 1977 and 1980 and 1980 and 1990, respectively.
(7) Compound growth for 32 years, 100-year life.
(8) Compound growth for 42 years, 100-year life.
(9) Compound growth for 40 years, 90-year life, interest and amortization at 7 5/8 percent (0.07635).
(10) Compound growth for 30 years, 80-year life, interest and amortization at 7 5/8 percent (0.07646).
(11) Compound growth for 20 years, 70-year life, interest and amortization at 7 5/8 percent (0.07670).
(12) Compound growth for 10 years, 60-year life, interest and amortization at 7 5/8 percent (0.0772).
(13) Because this is a constant annuity, the value is the same - for 50 years - interest and amortization for 50 years = 0.07823.

As the new residential units are added to the floodplain, their damages will increase over time, similar to damages to existing structures. Under the same assumptions and growth used for existing units, these damages are projected to change. Table G-23 summarizes the change for the new units. The per unit damages can be found by dividing the total undiscounted damages per decade by the number of new units shown in table G-22.

Commercial - All commercial growth must comply with floodplain regulations. The number of acres of commercial-industrial development that will be located in the floodplain has been determined in Appendix F. The type and damage susceptibility of future units cannot be projected from existing information. No new damages are included in this analysis.

Public - Public facilities are interconnected systems. Damages projected for the public under the existing development also include damages to new damageable growth. Table G-28 reflects changes in public damages.

Growth to Existing Development - All Portions of the Study Area

Residential - The Fargo regional growth rate for per capita income was used as the basis for increasing the real value of residential contents in the future to account for the effects of the affluence factor. The value of residential contents was projected to increase with the per capita income growth rate to a maximum level of 75 percent of the value of the residential structure. The projected 75-percent increase occurred in the year 2018 for the Sheyenne River communities and the year 2014 for Grand Forks. After these dates, the value of contents was held constant. Growth in contents damages for new development in West Fargo is calculated separately. Development of future residential damages is shown in tables G-24 through G-27.

Table G-24 - Application of OBERS per capita income projection to existing residential contents

Community or reach	Estimated value of residential structures ($1,000) (1)	Estimated value of residential contents ($1,000) (2) (1) x 0.25	75 percent of structural value ($1,000) (3) (1) x 0.75	75 percent of structural value divided by value of contents (4) (3) ÷ (2)
Valley City	39,976	9,994	29,982	3.00
Lisbon	7,379	1,845	5,534	3.00
Horace	3,876	969	2,907	3.00
West Fargo	72,780	18,195	54,585	3.00
Harwood	6,480	1,620	4,860	3.00
Argusville	1,127	282	845	3.00
Gardner	917	229	688	3.00
Reach 5A	7,120	1,780	5,340	3.00
Reach 5B	9,885	2,471	7,414	3.00
Reach 5D	13,873	3,468	10,405	3.00
Reach 5E	2,386	597	1,790	3.00
Total Sheyenne River basin	165,799	41,450	124,350	

The value of residential contents can increase by the factor 3.00

Item	Year	Fargo-Moorhead BEA 097 (Ave. Series "C" & E")
OBERS per capita income (1967 dollars)	1977	$3,372
	1980	3,692
	1990	4,951
	2000	6,767
	2010	9,132
	2020	11,869
	2030	14,605
	2040	17,200

$17,200 ÷ $3,372 = 5.1008

Amount of 1, 63 years: For 5.1008 = 2 5/8 percent

Year	Period 1	Factor amount of 2 5/8% growth rate
1977	0	-
1980	3	1.081
1990	13	1.401
2000	23	1.815
2010	33	2.352
2019	42	2.969 (1)
2020	43	3.047
2030	53	3.948
2040	63	5.116

(1) Nearest equal factor + 0.3.

Table G-25 - Number of urban existing(1) structures expected to receive direct damages without the project by decade (1977 conditions)

Area	Property type	Existing 1977	1980	1990	2000	2010	2019	2020	2030	2040
Valley City	Residential	625	625	625	625	625	625	625	625	625
	Commercial	67	67	67	67	67	67	67	67	67
	Public	0	0	0	0	0	0	0	0	0
	Semipublic	0	0	0	0	0	0	0	0	0
Lisbon	Residential	161	161	161	161	161	161	161	161	161
	Commercial	3	3	3	3	3	3	3	3	3
	Public	2	2	2	2	2	2	2	2	2
	Semipublic	0	0	0	0	0	0	0	0	0
Horace	Residential	123	123	123	123	123	123	123	123	123
	Commercial	0	0	0	0	0	0	0	0	0
	Public	0	0	0	0	0	0	0	0	0
	Semipublic	0	0	0	0	0	0	0	0	0
West Fargo and Riverside	Residential	1,636	1,636	1,636	1,636	1,636	1,636	1,636	1,636	1,636
	Commercial	146	146	146	146	146	146	146	146	146
	Public and semipublic	42	42	42	42	42	42	42	42	42
Harwood	Residential	85	85	85	85	85	85	85	85	85
	Commercial	6	6	6	6	6	6	6	6	6
	Public	2	2	2	2	2	2	2	2	2
	Semipublic	0	0	0	0	0	0	0	0	0
Argusville	Residential	42	42	42	42	42	42	42	42	42
	Commercial	6	6	6	6	6	6	6	6	6
	Public	2	2	2	2	2	2	2	2	2
	Semipublic	0	0	0	0	0	0	0	0	0
Gardner	Residential	35	35	35	35	35	35	35	35	35
	Commercial	0	0	0	0	0	0	0	0	0
	Public	0	0	0	0	0	0	0	0	0
	Semipublic	0	0	0	0	0	0	0	0	0
Reach 5-A	Residential	172	172	172	172	172	172	172	172	172
	Commercial	0	0	0	0	0	0	0	0	0
	Public	0	0	0	0	0	0	0	0	0
	Semipublic	0	0	0	0	0	0	0	0	0
Reach 5-B	Residential	208	208	208	208	208	208	208	208	208
	Commercial	0	0	0	0	0	0	0	0	0
	Public	0	0	0	0	0	0	0	0	0
	Semipublic	0	0	0	0	0	0	0	0	0
Reach 5-D	Residential	316	316	316	316	316	316	316	316	316
	Commercial	0	0	0	0	0	0	0	0	0
	Public	0	0	0	0	0	0	0	0	0
	Semipublic	0	0	0	0	0	0	0	0	0
Reach 5-E	Residential	113	113	113	113	113	113	113	113	113
	Commercial	0	0	0	0	0	0	0	0	0
	Public	0	0	0	0	0	0	0	0	0
	Semipublic	0	0	0	0	0	0	0	0	0
River Tree	Residential	40	40	40	40	40	40	40	40	40
	Commercial	0	0	0	0	0	0	0	0	0
	Public and semipublic	0	0	0	0	0	0	0	0	0
Brook Tree	Residential	24	24	24	24	24	24	24	24	24
	Commercial	0	0	0	0	0	0	0	0	0
	Public and semipublic	0	0	0	0	0	0	0	0	0

(1) For new growth, see table G-22.

Table G-16 - Average annual unit residential damages (October 1978 prices) (1977 conditions)

Area	Residential category	Average annual residential damages (1) ($1,000)	Number of structures	Average annual damages per unit
Valley City	Total	1,269	625	$2,030
	Structure	761	625	1,218
	Contents	508	625	812
Lisbon	Total	219	161	1,360
	Structure	131	161	814
	Contents	88	161	546
Horace	Total	296	123	2,406
	Structure	178	123	1,447
	Contents	118	123	959
West Fargo and Riverside	Total	11,310	1,636	6,913
	Structure	6,786	1,636	4,148
	Contents	4,524	1,636	2,765
Harwood	Total	307	128	2,398
	Structure	184	128	1,438
	Contents	123	128	961
Argusville	Total	157	42	3,738
	Structure	94	42	2,238
	Contents	63	42	1,500
Gardner	Total	48	35	1,371
	Structure	29	35	829
	Contents	19	35	542
Reach 5A	Total	722	172	4,198
	Structure	433	172	2,517
	Contents	289	172	1,681
Reach 5B	Total	707	208	3,399
	Structure	424	208	2,038
	Contents	283	208	1,361
Reach 5D	Total	939	316	2,972
	Structure	563	316	1,782
	Contents	376	316	1,190
Reach 5E	Total	308	113	2,726
	Structure	185	113	1,637
	Contents	123	113	1,089
River Tree	Total	170	40	4,250
	Structure	102	40	2,550
	Contents	68	40	1,700
Brook Tree	Total	58	24	2,417
	Structure	35	24	1,459
	Contents	23	24	958

(1) From the St. Paul District's Depth Damage tables. 40 percent of the damages are to contents and 60 percent of the damages are to structures.

Table G-27 - Present and future average annual residential damages (1977 conditions)

	1977	1980	1990	2000	2010	2019	2020	2030	2040	Increase (1990-2040)	Average[1] annual equivalent factor	Average annual equivalent of increase	Equivalent average annual damages
Valley City	$1,269,000	$1,310,000	$1,472,500	$1,682,500	$1,955,100	$2,268,000	$2,268,000	$2,268,000	$2,268,000	$796,000	.3809	$303,000	$1,775,500
Lisbon	219,000	226,000	254,200	290,600	337,800	392,000	392,000	392,000	392,000	138,000	.3809	53,000	307,200
Horace	296,000	305,500	343,300	392,100	455,300	528,200	528,200	528,200	528,200	185,000	.3809	70,000	413,300
West Fargo and Riverside	11,310,000	11,676,100	13,124,000	14,995,600	17,425,000	20,216,100	20,216,100	20,216,100	20,216,100	7,092,000	.3809	2,701,000	15,825,000
Harwood	307,000	318,600	356,200	407,000	472,900	548,600	548,600	548,600	548,600	192,000	.3809	73,000	429,200
Argusville	157,000	162,100	182,300	208,400	242,200	281,100	281,100	281,100	281,100	99,000	.3809	38,000	220,300
Gardner	48,000	49,500	55,600	63,500	73,600	85,300	85,300	85,300	85,300	30,000	.3809	11,000	66,600
Reach 5-A	722,000	745,400	838,000	957,700	1,113,000	1,291,400	1,291,400	1,291,400	1,291,400	453,000	.3809	173,000	1,011,000
Reach 5-B	707,000	729,900	820,600	937,700	1,089,700	1,264,400	1,264,400	1,264,400	1,264,400	444,000	.3809	169,000	989,600
Reach 5-D	939,000	969,500	1,089,900	1,245,700	1,447,600	1,679,500	1,679,500	1,679,500	1,679,500	590,000	.3809	225,000	1,314,900
Reach 5-E	308,000	318,000	357,400	408,400	474,400	550,300	550,300	550,300	550,300	203,000	.3809	77,000	434,400
Rivertree Park	170,000	175,500	197,300	225,400	261,900	303,900	303,900	303,900	303,900	107,000	.3809	41,000	238,300
Brooktree Park	58,000	59,900	67,200	76,800	89,100	103,300	103,300	103,300	103,300	36,000	.3809	14,000	108,200
Total Sheyenne River	16,510,000	17,046,000	19,158,500	21,891,400	25,437,600	29,512,100	29,512,100	29,512,100	29,512,100	10,365,000		3,948,000	23,133,500

(1) Average annual equivalent factor for 100-year life, 29-year growth for 7 5/8 percent interest is .3809.

Commercial - Commercial and industrial damages are also likely to increase in the future as net investment increases. No published index or group of indexes would represent the variety of growth patterns each business could take. No commercial growth is projected for the project area. Damages for the study area are summarized in table G-4 and do not change.

Public - Public structures must also be flood proofed as much as practical in keeping with their functions. Unfortunately, the public properties which receive the most damage - parks, streets, sewers, and water treatment facilities - are often impossible to flood proof. West Fargo has already flood proofed these structures as much as practically possible. Existing conditions reflect residual damages to flood proofed structures. Flood fight costs and emergency services, the major public damage expenditures, are also projected to increase as the area protected increases. Not only are the new facilities going to be subject to damage, old facilities such as parks and sewer systems that are in the floodplain will have to be upgraded and expanded. Public damage growth will be in both new and existing public facilities and be proportionate to the demand. Demand is expected to change at the same rate population changes. Changes in public damages are summarized in table G-28.

Table G-28 - Present and future average annual public damages(1)

Location	Damages ($1,000) 1977	1980(2)	1990(3)	2000(4)	2010(4)	2020(4)	2030(4)	2040(4)	Increase 1990-2040 ($1,000)	Average annual equivalent factor(5)	Average annual equivalent of increase ($1,000)	Equivalent average annual damage ($1,000)
Valley City	54	54	58	59	61	64	66	68	10	0.2747	3	62
Index	(1.000)	(1.000)	(1.068)	(1.024)	(1.060)	(1.096)	(1.133)	(1.133)				
Lisbon	48	49	49	51	53	53	55	58	9	0.2747	2	51
Index	(1.000)	(1.000)	(1.006)	(1.043)	(1.087)	(1.087)	(1.130)	(1.174)				
Horace	33	38	45	56	68	81	[illegible]	97	52	0.2747	14	59
Index	(1.000)	(1.153)	(1.187)	(1.252)	(1.511)	(1.800)	(1.978)	(2.158)				
West Fargo and Riverside	571	681	878	1,047	1,202	1,364	1,587	1,783	905	0.2747	249	1,127
Index	(1.000)	(1.193)	(1.290)	(1.192)	(1.369)	(1.554)	(1.808)	(2.031)				
Argusville	17	18	18	18	18	18	18	18	0	0.2747	0	18
Index	(1.000)	(1.065)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)	(1.000)				
Harwood	16	18	20	23	26	29	32	35	15	0.2747	4	24
Index	(1.000)	(1.101)	(1.092)	(1.149)	(1.301)	[illegible]	(1.601)	(1.750)				
Total Sheyenne River	739	858	1,068	1,254	1,428	1,609	1,847	2,059	991	0.2747	272	1,340

(1) October 1980 prices, 7 5/8-percent interest rate.
(2) Index of change is from 1977 to 1980.
(3) Index of change is from 1980 to 1990.
(4) Index of change is from 1990.
(5) Average annual equivalent factor for 100-year life, 50-year growth, 7 5/8-percent interest rate.

Table G-29 summarizes total urban damages for the Sheyenne River basin. Of the $26,528,000 average annual urban damages, $24,333,800 (92 percent) occur in the area downstream of Kindred. The city of West Fargo has $18,995,000 average annual equivalent damages (72 percent of the total urban damages in the basin). The small communities and rural subdivisions account for the remaining urban damages downstream of Kindred.

Table [illegible] Summary of average annual flood damages[1]

Location	Category	Damages ($1,000) [illegible]	1990	[illegible]	2000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] equivalent factor	Average annual equivalent increase ($1,000)	Equivalent average annual damage ($1,000)
Valley City	Residential	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Commercial	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	Public	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
	Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
Lisbon	Residential	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Commercial	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
	Public	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]	Residential	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
	Commercial													
	Public	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]	Residential	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].3809	[illegible]	[illegible]
	Commercial	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
	Public	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Nonresidential	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
	Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]	Residential	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Commercial													
	Public	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]	Residential	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Commercial													[illegible]
	Public											[illegible]		[illegible]
	Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]
[illegible]	Residential	[illegible]	59.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Commercial	[illegible]	[illegible]				[illegible]			[illegible]			[illegible]	[illegible]
	Public	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]		0
	Total	58	59.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			81.2
[illegible]	Residential	15[illegible]	[illegible]	182.[illegible]	208.[illegible]	242.[illegible]	281.[illegible]	281.[illegible]	281.[illegible]	281.[illegible]	99	[illegible].3809	38	220.[illegible]
	Commercial	9	9	9	9	9	9	9	9	9	[illegible]		0	9
	Public	17	17	18	18	18	18	18	18	18	0	[illegible]		18
	Total	183	189.1	209.3	235.[illegible]	269.2	308.1	308.1	308.[illegible]	308.1	99			24[illegible]
[illegible]	Residential	[illegible]	49.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible].3809	[illegible]	[illegible]
	Commercial		[illegible]					[illegible]						[illegible]
	Public		0	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]
	Total	[illegible]	49.[illegible]	53.[illegible]	[illegible]	[illegible]	[illegible]	85.3	[illegible]	85.3	[illegible]			[illegible]
[illegible]	Residential	[illegible]	[illegible]	838	[illegible]	1,[illegible]	1,291.[illegible]	1,291.[illegible]	1,291.[illegible]	1,291.[illegible]	[illegible]	[illegible].3809	[illegible]	[illegible]
	Commercial				[illegible]		[illegible]	[illegible]		[illegible]			[illegible]	
	Public	[illegible]	0	0	0	0	0	0	[illegible]	[illegible]	[illegible]		[illegible]	0
	Total	[illegible]	[illegible]	838	[illegible]	1,113	1,291.[illegible]	1,291.[illegible]	1,291.[illegible]	1,291.[illegible]	[illegible]			[illegible]
[illegible]	Residential	[illegible]	729.[illegible]	[illegible]	[illegible]	1,089.[illegible]	1,26[illegible]	[illegible]	1,26[illegible]	1,26[illegible]	[illegible]	[illegible].3809	164	[illegible]
	Commercial	[illegible]			[illegible]	[illegible]	[illegible]			[illegible]				[illegible]
	Public		0	[illegible]	[illegible]		[illegible]		[illegible]	[illegible]	[illegible]			[illegible]
	Total	[illegible]	729.[illegible]	[illegible]	[illegible]	1,089.[illegible]	1,26[illegible]	1,26[illegible]	1,26[illegible]	1,26[illegible]	[illegible]			[illegible]
[illegible]	Residential	939	969.[illegible]	1,089.9	1,24[illegible]	1,4[illegible]	1,679.5	1,679.5	1,679.5	1,679.5	590	0.3809	22[illegible]	1,31[illegible].9
	Commercial	[illegible]	0	0	[illegible]		[illegible]	[illegible]	0		0		[illegible]	0
	Public	0	[illegible]	0	[illegible]	0	0	0	0	[illegible]	[illegible]	0.2[illegible]		0
	Total	939	969.[illegible]	1,089.9	1,24[illegible]	1,4[illegible].6	1,679.5	1,679.5	1,679.5	1,679.5	590			1,31[illegible].9
[illegible]	Residential	308	318	35[illegible]	408.[illegible]	[illegible]	550.3	550.3	550.3	550.3	[illegible]	0.3809	[illegible]	[illegible]
	Commercial	0	0	0	[illegible]	[illegible]	0	0	[illegible]	0	0		0	0
	Public			[illegible]		[illegible]		[illegible]			0	0.2[illegible]	0	[illegible]
	Total	308	318	[illegible]	408.[illegible]	[illegible]	550.3	550.3	550.3	550.3	[illegible]			[illegible]
Total Sheyenne River		[illegible]	[illegible]	22,[illegible]	[illegible]	[illegible]	-	[illegible]	[illegible]	[illegible]				26,[illegible]

[1] October 1980 prices, [illegible]-percent interest rate.

AGRICULTURE

Farmers in the study area are becoming more aggressive in their management practices. Investments in land and machinery are larger than ever before. More and better information is available on new products, marketing, and methods of production through extension agents, government agencies, and cooperatives. Sugar beet cooperatives now handle the beets from cultivation to marketing.

Local U.S. Department of Agriculture and extension officials indicate that the trend appears to be toward following market prices more closely. Farmers have shown a tendency to shift to the higher valued crops which can be grown in the area. These crops are mostly specialty crops: processing potatoes, sunflowers, pinto beans, canary grass, mustard, and others. Wheat will still be the dominant source of income for the lower basin, but its percentage of total crop income is expected to decline.

The ratio of livestock to crops in the basin seems to be stable. Unless there are major policy changes, land put into cultivation is expected to equal land going out of cultivation. A few acres every year will be lost to urbanization. But because of the floodplain zoning ordinances and the high profitability of this land as cropland, urbanization is not expected to significantly affect the floodplain acreages.

Crop income projections made by the U.S. Economic Research Service (ERS) for the Red River of the North region were published in the 1972 OBERS Series E projection report. This projection takes into account current crops only; the more highly valued specialty crops are not included. It is too early to project the impact of specialty crops, but increases should be greater than those projected in table G-30. This table shows the projected change in income for each reach weighted by the current land use in the area. Damages can be expected to increase at the same rate.

Table G-30 - Summary of future agriculture growth indexes

Reach	1977	1980	1990	2000	2010	2020	2030	2040
2								
1977	1.000	1.047	1.170	1.275	1.358	1.44	1.523	1.611
1985			1.000	1.091	1.162	1.272	1.303	1.379
3								
1977	1.000	1.048	1.192	1.297	1.388	1.478	1.568	1.663
1980			1.000	1.086	1.164	1.240	1.315	1.395
4								
1977	1.000	1.040	1.179	1.285	1.379	1.471	1.564	1.663
1985			1.000	1.090	1.169	1.247	1.330	1.418
5A								
1977	1.000	1.048	1.203	1.362	1.485	1.568	1.713	1.871
1985			1.000	1.532	1.234	1.304	1.424	1.555
5B								
1977	1.000	1.045	1.195	1.360	1.463	1.566	1.660	1.760
1985			1.000	1.138	1.224	1.310	1.389	1.47
5C								
1977	1.000	1.045	1.191	1.351	1.459	1.561	1.664	1.774
1985			1.000	1,132	1.225	1.311	1.397	1.489
5D								
1977	1.000	1.045	1.191	1.346	1.463	1.572	1.682	1.800
1985			1.000	1.132	1.228	1.320	1.412	1.511
5E								
1977	1.000	1.047	1.203	1.375	1.496	1.612	1.729	1.854
1985			1.000	1.143	1.243	1.340	1.437	1.542

Other agricultural damages are projected to increase at the same rate as crop damage. Average annual agricultural damages are illustrated on the damage summary table on page G-55.

TRANSPORTATION

Railways, bridges, roadways, and culverts frequently have a long economic life. Repair costs, even with frequent flooding, would rarely exceed the cost of a new structure. Development has taken place along existing networks, and sufficient land exists for more development. Awareness of the flood problem is sufficient that any new facilities will be built to minimize damages. No change in transportation damages is expected throughout the project life.

SUMMARY

The following table summarizes all existing and future damages in the study area. Total average annual damages at a discount rate of 7 5/8 percent are expected to be $27,778,500.

Table G-31 - Summary of present and future average annual damages: urban, agricultural, and transportation

Location	Damage per acre	Average annual acres flooded	Damages[1] 1977	1980	1990	2000	2010	2019	2020	2030	2040	Net change in damages 1990-2040	Average annual equivalent factor	Average annual equivalent change	Total average annual equivalent damages	Index [illegible] using budgetary indexes	Total average annual damages October 1981 prices
Urban																	
Valley City			$1,350,000	$1,395,000	$1,557,500	$1,768,500	$2,043,100	$2,359,000	$2,359,000	$2,361,000	$2,363,000	$806,000	0.379[2]	$306,000	$1,86[illegible]		$1,9[illegible]
Lisbon			270,000	278,000	306,200	344,600	393,800	448,000	448,000	450,000	453,000	147,000	0.3742	55,000	361,200		376,700
Horace			329,000	343,500	388,300	448,100	523,300	608,200	609,200	617,200	625,200	237,000	0.3544	84,000	472,300		492,600
West Fargo			13,405,000	13,983,100	15,822,500	18,057,600	20,952,500	-	24,059,600	24,613,100	25,118,100	9,295,600	(3)	(3)	18,995,000		19,811,400
Gardner			48,000	49,500	55,600	63,500	73,600	85,300	85,300	85,300	85,300	30,000	0.3666	11,000	66,600		69,500
Argusville			157,000	189,100	209,300	235,400	269,200	308,100	308,100	308,100	308,100	99,000	0.3809	38,000	247,300	1.043	257,900
Harwood			326,000	339,600	379,200	433,000	501,900	580,600	580,600	583,600	586,600	207,000	0.3720	77,000	456,200		475,900
Rivertree Park			170,000	175,500	197,300	225,400	261,900	303,900	303,900	303,900	303,900	107,000	0.3804	41,000	238,300		248,500
Brooktree Park			58,000	59,900	67,200	76,800	89,100	103,300	103,300	103,300	103,300	36,000	0.3809	14,000	81,200		84,700
Nonurban 5-A			722,000	745,400	838,000	957,700	1,113,000	1,291,400	1,291,400	1,291,400	1,291,400	453,000	0.3809	173,000	1,011,000		1,054,500
Nonurban 5-B			707,000	729,900	820,600	937,700	1,089,700	1,264,400	1,264,400	1,264,400	1,264,400	444,000	0.3809	169,000	989,600		1,032,200
Nonurban 5-D			939,000	969,500	1,089,900	1,245,700	1,447,600	1,679,500	1,679,500	1,679,500	1,679,500	590,000	0.3809	225,000	1,314,900		1,371,400
Nonurban 5-E			308,000	318,000	357,400	408,400	474,400	550,300	550,300	550,300	550,300	193,000	0.3809	74,000	431,400		450,000
Subtotal			18,815,000		22,089,000										26,528,500		27,669,200
Agricultural-Crop																	
Reach 2	54.91	400	1,964	2,056	2,298	2,504	2,667		2,828	2,491	3,164	866		200[5]	2,500[5]		2,700
Reach 3	15.11	600	9,066	9,501	10,807	11,759	12,584		13,400	14,215	15,077	4,270		1,200	12,000		13,100
Reach 4	13.68	2,100	28,728	29,877	33,870	36,915	39,616		42,259	44,931	47,775	13,905		3,800	37,700		41,000
Reach 5-A	31.77	1,500	47,655	49,942	57,379	64,906	70,768		74,723	81,633	89,163	31,834	0.2747[4]	8,700	66,000	1.088	71,800
Reach 5-B	33.53	1,000	33,530	35,039	40,068	45,601	49,054		52,508	55,660	59,013	18,945		5,200	45,300		49,300
Reach 5-C	36.70	550	20,185	21,093	24,040	27,270	29,450		32,509	33,588	35,808	11,768		3,200	27,200		29,600
Reach 5-D	34.24	8,100	277,344	289,824	330,317	373,860	405,754		435,985	466,493	499,219	168,900		46,400	376,700		409,900
Reach 5-E	33.94	3,000	101,820	106,606	122,489	140,003	152,323		164,134	176,047	188,774	66,285		18,200	140,700		153,100
Subtotal			520,292		621,218										708,100		770,400
Other agricultural																	
Reach 2	4.39	400	1,756	1,839	2,055	2,239	2,385		2,529	2,674	2,829	774		200	2,300		2,600
Reach 3	7.85	600	4,710	4,936	5,614	6,109	6,537		6,961	7,835	7,833	2,219		600	6,200		7,000
Reach 4	7.01	2,100	14,721	15,310	17,356	18,916	20,300		21,655	23,024	24,481	7,125		2,000	19,400		22,000
Reach 5-A	15.58	1,500	23,370	24,492	28,114	31,830	34,704		36,644	40,033	43,725	15,611	0.2747	4,300	32,400	1.134	36,700
Reach 5-B	15.58	1,000	15,580	16,281	18,618	21,189	22,794		24,398	25,863	27,421	8,803		2,400	21,000		23,800
Reach 5-C	15.58	550	8,569	8,955	10,206	11,577	12,502		13,376	14,259	15,201	4,995		1,400	11,600		13,200
Reach 5-D	15.58	8,100	126,198	131,877	150,302	170,115	184,628		198,383	12,265	227,156	76,854		21,100	171,400		194,400
Reach 5-E	15.58	3,000	46,740	48,937	56,228	64,268	69,923		75,345	80,813	86,656	30,428		8,400	64,600		73,300
Subtotal			241,644		288,493										328,900		373,000
Transportation																	
Reach 2			38,000		38,000			No change							38,000		40,700
Reach 3			39,000		39,000			No change							39,000		41,800
Reach 4			29,000		29,000			No change							29,000	1.071	31,100
Reach 5			77,000		77,000			No change							77,000		82,500
Subtotal			183,000		183,000			No change							183,000		196,100
Total			19,759,936		23,181,711										27,748,500		29,008,700

(1) October 1980 prices, 7 5/8-percent interest rate.
(2) The urban factor was derived artificially and represents all three growth patterns.
(3) Changes in new development are not in constant dollars and are not on a comparable basis.
(4) Growth paths approximate straight-line growth.
(5) Rounded to nearest hundred.

BENEFITS

FLOOD CONTROL

Flood control benefits are summarized in table G-32.

The levee and diversion around West Fargo are designed to protect against the standard project flood. This degree of protection would reduce average annual damages by 98.01 percent and result in benefits of $18,786,000 in 1980 prices ($19,695,000 in 1981 prices).

The second element recommended for Corps implementation is a 5-foot raise of Baldhill Dam. This raise would provide 30,000 acre-feet of additional flood control storage. This storage could significantly affect Valley City, Lisbon, and the rest of reaches 2 and 3. Total damages in this area are $2,324,700. Benefits attributable to the raise of Baldhill Dam would be $1,388,800 in 1980 prices ($1,453,600 in 1981 prices).

Additional benefits would accrue in reaches 4, 5A, and 5B. These benefits can be measured, although they depend to some extent on assumptions used in evaluating the other plan components, namely Dead Colt Creek Dam and the flood diversion channel from Horace to West Fargo. Preliminary estimates of these additional benefits for the raise of Baldhill Dam, although not displayed in table G-32, show that they could range from $500,000 to $800,000. A decrease could also occur in the benefits attributable to the flood diversion channel from Horace to West Fargo, depending on the assumptions used.

Substantial damages occur in reach 5-B from Horace to West Fargo. This reach has a great deal of the nonurban residential development. A levee and diversion through this reach are recommended for Corps implementation. Although the proposed design of this element would provide greater than 100-year protection, flooding from overland flows from reach 5-A is always possible. It is estimated that a fairly reliable 50-year degree of protection would be provided. Transportation benefits were estimated by finding a dollar per acre transportation damage value and applying it to the acres benefited. Benefits for this plan would be $1,324,900 ($1,383,000 in 1981 prices). Damages in this reach would be reduced by 86 percent.

Total benefits for Corps implemented elements are $22,431,600 in 1981 prices.

Table G-32 - Benefit summary for plan recommended for Corps of Engineers implementation(1)

Plan element	Average annual acres benefited	Benefits 1977	1980(2)	1990	2000	2010	2019	2020	2030	2040	Net change in benefits 1990-2040	Average annual equivalent factor	Average annual equivalence of change(3)	Average annual equivalent benefits	Index to 1981(4)	Average annual equivalent benefits October 1981 prices(5)
Levees and diversion around West Fargo																
West Fargo																
Existing development		$13,311,000	$13,777,000	$15,414,000	$17,437,000	$20,006,000	$22,922,000	$22,935,000	$23,148,000	[illegible]	$7,933,000	0.3689	$2,926,000	$18,340,000	1.043	$19,129,000
New development			80,000	231,000	383,000	547,000	-	745,000	1,003,000	1,244,000				405,000	1.043	422,000
Agricultural reach 5-C	540	28,000	29,000	33,000	38,000	41,000	-	44,000	47,000	50,000	17,000	0.2747	5,000	38,000	1.088	41,000
Transportation	540	2,900	3,000	3,000	3,000	3,000		3,000	3,000	3,000				2,900	1.071	3,000
Subtotal	1,080	13,341,900	13,889,000	15,681,000	17,861,000	20,597,000		23,727,000	24,201,000	24,644,000				18,785,000		[illegible]
5-foot raise of Baldhill Dam																
Valley City		893,700	923,600	1,031,000	1,171,000	1,331,000	1,561,000	1,561,000	1,563,000	1,564,000	533,000	0.3797	202,400	1,233,400	1.043	[illegible]
Lisbon		79,400	82,000	89,500	102,300	115,000	132,000	132,000	132,300	133,000	43,500	0.3761	16,300	105,800	1.043	110,000
Agricultural(6)																
Reach 2	243	2,300	2,400	2,600	3,000	3,100		3,300	3,500	3,700	1,100	0.2747	300	2,900	1.111	3,200
Reach 3	250	5,700	5,700	6,600	7,400	8,000		8,500	9,100	9,700	[illegible]	0.2747	800	7,400	1.111	8,400
Transportation																
Reach 2		27,000	27,000	27,000	27,000	27,000		27,000	27,000	27,000				27,000	1.071	29,000
Reach 3		12,100	12,100	12,100	12,100	12,100		12,100	12,100	12,100				12,100	1.071	[illegible]
Subtotal	493	1,020,200	1,052,200	1,168,800	1,322,500	1,514,200		1,743,900	1,746,700	1,749,500				1,388,600		1,453,600
Diversion from Horace to West Fargo																
Horace		293,000	300,000	346,000	399,000	531,000	542,000	543,000	550,000	557,000	211,000	0.3544	75,000	421,000	1.043	439,000
Nonurban reach 5-B		624,000	644,000	724,000	827,000	962,000	1,116,000	1,116,000	1,116,000	1,116,000	392,000	0.3809	149,000	873,000	1.043	911,000
Agricultural reach 5-B	420	20,600	22,000	25,000	28,000	30,000		32,000	34,000	36,000	11,000	0.2747	3,000	28,000	1.098	30,000
Transportation	420	2,900	2,900	2,900	2,900	2,900		2,900	2,900	2,900				2,900	1.071	3,000
Subtotal	840	940,500	968,900	1,097,900	1,256,900	1,525,900		1,693,900	1,704,900	1,711,900				1,324,900		1,383,000
Total														21,498,700		[illegible]

(1) October 1980 price levels, 7 5/8-percent interest rate.
(2) Same growth rate as table G-29.
(3) Derived from table G-29.
(4) Indexes used are those used for budgetary purposes.
(5) Rounded to nearest 1,000.
(6) Agricultural benefits include reductions in both crop and other agricultural damages. See page G-37.

(R 3/83)

COST SAVINGS FOR FLOOD PROOFING

As discussed in the social and economic base Appendix F, insignificant costs are incurred for most flood proofing because, with the basement exempt in floodplain regulations, very little fill is needed. No benefits have been taken for flood proofing cost savings.

ENHANCEMENT

It would be difficult for the recommended project to enhance the land it protects. This land is already very desirable as outlined in Appendix F. No enhancement benefit is taken.

COST SAVINGS IN FLOOD INSURANCE

The levee and diversion at West Fargo will provide standard project flood protection to West Fargo and Riverside. These communities will no longer be required to buy flood insurance. The savings in administrative cost associated with eliminating this requirement are $39 per policy. West Fargo has 1,003 active policies and Riverside 189. Total average annual cost savings in flood insurance are $46,500 (1,003 policies plus 189 policies x $39).

TOTAL BENEFITS OF RECOMMENDED PLAN

	October 1980 prices	October 1981 prices
Flood control	$21,489,700	$22,431,600
Savings in flood insurance administrative costs	46,500	46,500 (1)
Total	21,544,200	22,478,100

(1) There is no anticipated change to October 1981 prices; however, as of 1 January 1982 these costs are expected to increase to $63 per policy.

Table G-32A - Flood damage reduction impact summary
(7 5/8% interest, October 1981 prices)

Location	Total average annual damages	Total average annual benefits	Total average annual residual damages
Urban			
Valley City	$ 1,943,600	$ 1,290,000	$ 653,600
Lisbon	376,700	110,000	266,700
Horace	492,600	439,000	53,600
West Fargo	19,811,800	19,551,000	260,800
Gardner	69,500	0	69,500
Argusville	257,900	0	257,900
Harwood	475,800	0	475,800
Rivertree Park	248,500	0	248,500
Brooktree Park	84,700	0	84,700
Nonurban 5-A	1,054,500	0	1,054,500
Nonurban 5-B	1,032,200	911,000	121,200
Nonurban 5-D	1,371,400	0	1,371,400
Nonurban 5-E	450,000	0	450,000
Subtotal	27,669,200	22,301,000	5,368,200
Agricultural-Crop			
Reach 2	2,700	1,600	1,100
Reach 3	13,100	5,500	7,600
Reach 4	41,000	0	41,000
Reach 5-A	71,800	0	71,800
Reach 5-B	49,300	20,200	29,100
Reach 5-C	29,600	28,400	1,200
Reach 5-D	409,800	0	409,800
Reach 5-E	153,100	0	153,100
Subtotal	770,400	55,700	714,700
Other agricultural			
Reach 2	2,600	1,600	1,000
Reach 3	7,000	2,900	4,100
Reach 4	22,000	0	22,000
Reach 5-A	36,700	0	36,700
Reach 5-B	23,800	9,800	14,000
Reach 5-C	13,200	12,600	600
Reach 5-D	194,400	0	194,400
Reach 5-E	73,300	0	73,300
Subtotal	373,000	26,900	346,100
Transportation			
Reach 2	40,700	29,000	11,700
Reach 3	41,800	13,000	28,800
Reach 4	31,100	0	31,100
Reach 5	82,500	6,000	76,500
Subtotal	196,100	48,000	148,100
Total	29,008,700	22,431,600	6,577,100

RESIDUAL DAMAGES

Residual damages are $6,577,100. Table G-32 A illustrates residual damages for each part of the study area. Residual damages for new development will increase slightly. Units constructed after project completion will no longer have to be flood proofed. For catastrophic events, damages to these units will be greater. Using the same type of analysis described on page G-39, average annual residual damages are $176,000 as opposed to residual damages of $111,000 for homes that have been flood proofed. These increased damages are in addition to the residual damages discussed above.

FINANCIAL ANALYSIS

The benefit-cost ratio for the recommended plan is shown below.

Benefits	$22,478,100
Costs (1)	3,002,900
Benefit-cost ratio	7.5
Net benefits	19,475,200

(1) Costs can be found in Appendix J.

All project increments are economically feasible. The internal rate of return for the 5-foot raise of Baldhill Dam is 15-1/8 percent, for the diversion from Horace to West Fargo 13-3/8 percent, and for the levees and diversion around West Fargo greater than 15 percent. For the project as a whole, the internal rate of return is greater than 15 percent. The project break-even year is 1977.

SENSITIVITY ANALYSIS

GENERAL

A sensitivity analysis has been performed to check the sensitivity of the benefit analysis at West Fargo to the three most sensitive assumptions: (1) the appropriateness of our residential depth damage tables for West Fargo, (2) the representativeness of the slope of the base flood through town, and (3) that the emergency levees will fail.

Estimates of flood damages to residences and contents were obtained from depth-damage tables developed by the St. Paul District. These tables give the "average" expected damage for a given depth of flooding to a house of a specific market value. Because these tables were developed from districtwide data, it is wise to analyze a sample of floodplain residences to see if the tables are representative of a particular area. In October 1979, interviews were conducted with a random sample of 38 residents in the floodplain to determine what each unit's damage would be for various levels of inundation. The homes selected were single-family homes because they are the prevalent type of housing in the area. Comparisons of the characteristics of the sample homes with the total floodplain residences appear in table G-33.

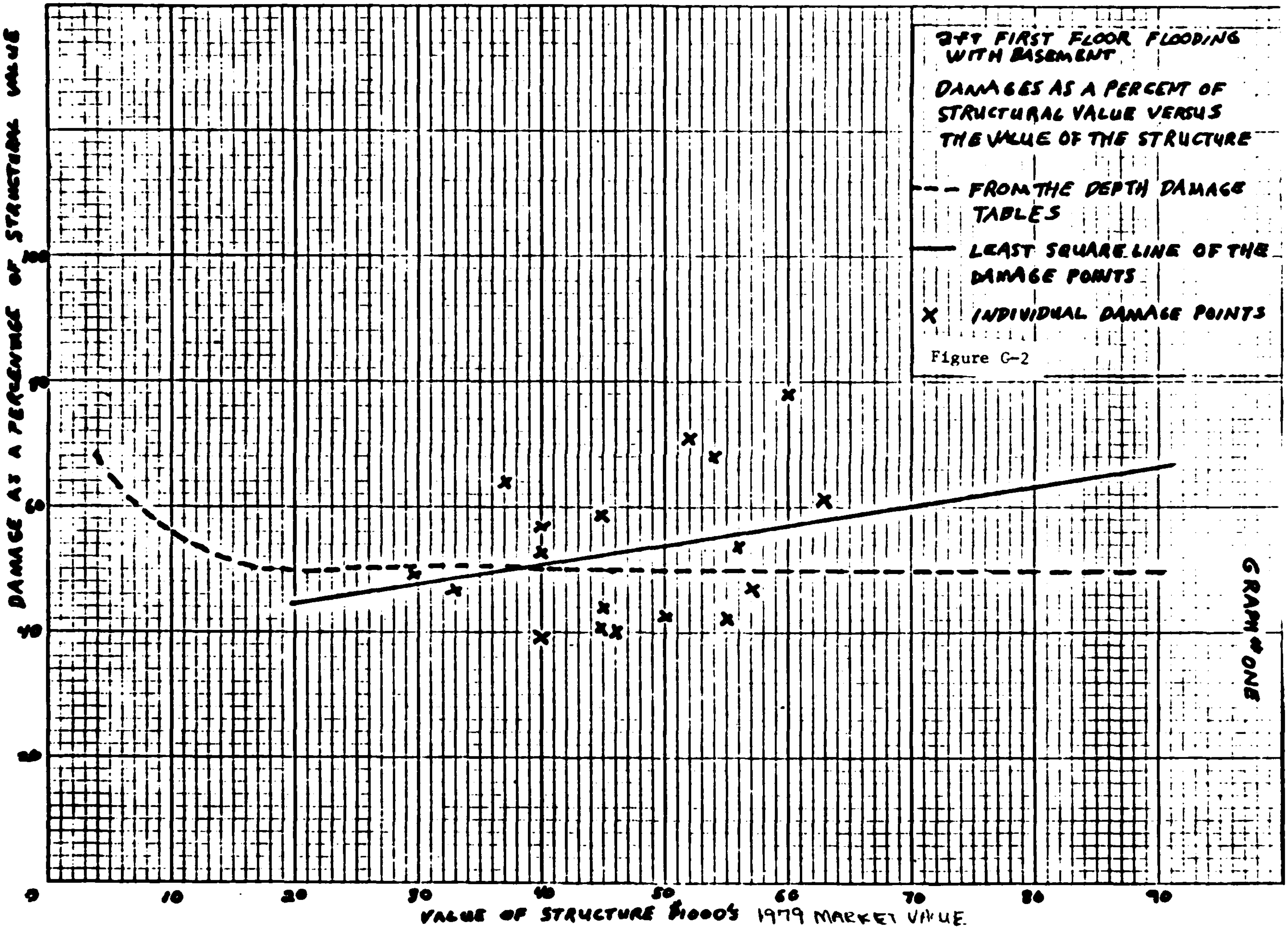
Table G-33 - Comparison of the characteristics of the sample population with the total population

Characteristic	Sample	Total
Number	38	1,520
Percent of total population	2.5	100
1976 average market value	$30,000	$31,000
Structure type		
With basement (percent)	84	79
Without basement (percent)	5	15
Split-entry (percent)	11	6
Market value range, 1976 values		
Less than $40,000 (percent)	28	14
$40,000 - $60,000 (percent)	53	31
$60,000 - $80,000 (percent)	14	44
Greater than $80,000 (percent)	5	11

Information was gathered for three flood damage levels: (1) 6 inches of water on the first floor for homes with no basements and either (2) 2-foot first-floor flooding or (3) 3-foot basement flooding for homes with basements depending on whether the theoretical level of the 1965 flood would give basement or first-floor flooding. Households with basements with 2-foot first-floor flooding tended to be in the lower central part of town. Houses with direct basement flooding tended to be located in higher areas, either near the river or on the eastern side of town. Homes without basements tended

to be in the older, northern part of town near the river. Split-levels were inventoried for either 2-foot first-floor flooding or 3-foot ground-floor flooding. Most of the spilt-levels were in the newer developments on the eastern side of town or in newer areas west of the river.

In addition to estimating damages for the designated level of flooding, each respondent was asked to estimate the current market value of his home so that we would have a somewhat current market value to compare with the "current" damages. Our market values in 1979 were 30 to 368 percent higher than the market values in 1976. The change in market value assumed most representative was used for updating the value of residential structures. See update section at the beginning of this appendix. The market values given by the owners for those homes under $100,000 were assumed to represent 1979 market conditions. Figures G-2, G-3, and G-4 summarize the results of the sample survey.



2 ft FIRST FLOOR FLOODING WITH BASEMENT
DAMAGES AS A PERCENT OF STRUCTURAL VALUE VERSUS THE VALUE OF THE STRUCTURE
FROM THE DEPTH DAMAGE TABLES
LEAST SQUARE LINE OF THE DAMAGE POINTS
X INDIVIDUAL DAMAGE POINTS
GRAPH # ONE
DAMAGE AS A PERCENTAGE OF STRUCTURAL VALUE
VALUE OF STRUCTURE $1000's 1979 MARKET VALUE
0
10
20
30
40
50
60
70
80
90
100

Figure G-2

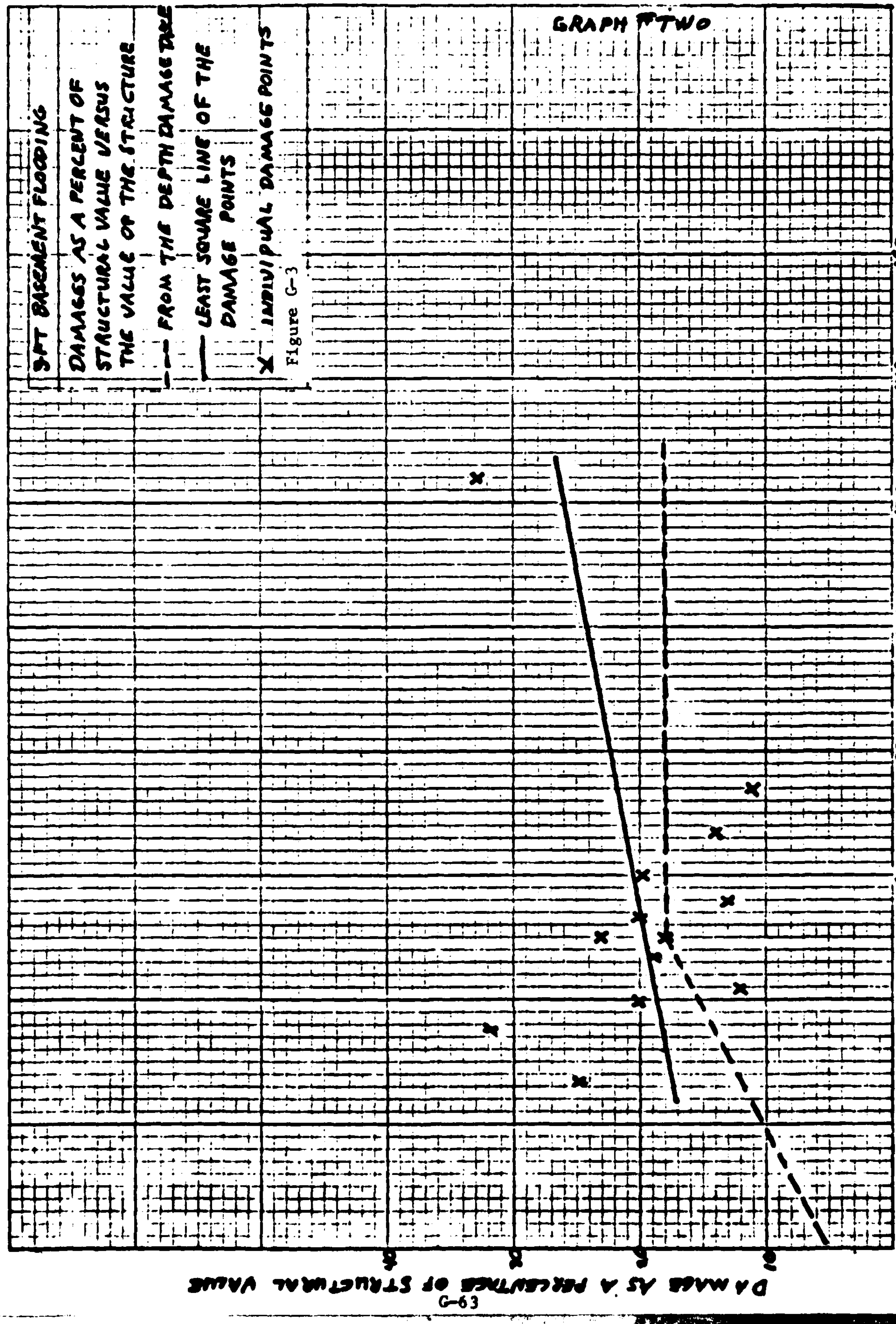
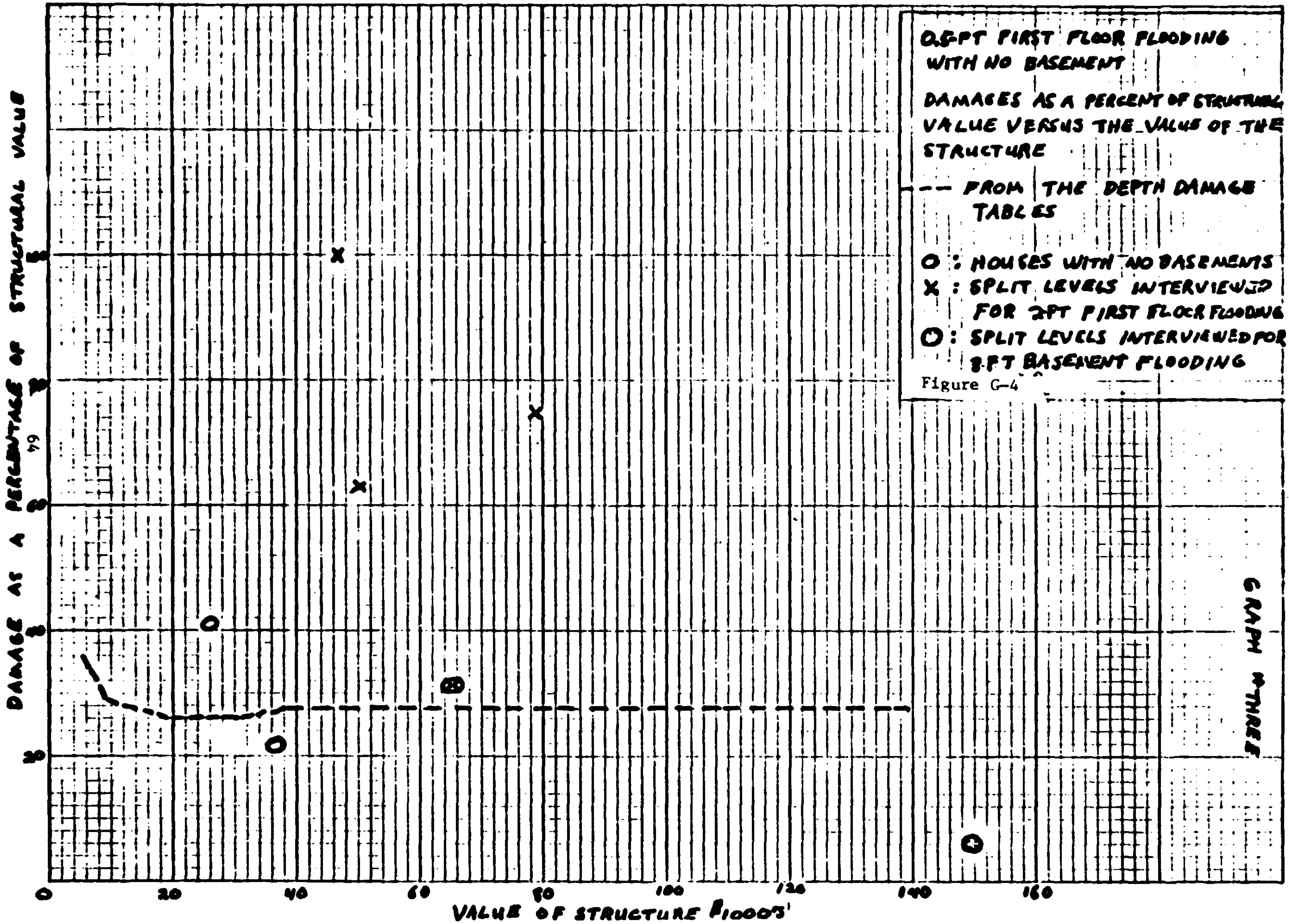

GRAPH #TWO
3 FT BASEMENT FLOODING
DAMAGES AS A PERCENT OF STRUCTURAL VALUE VERSUS THE VALUE OF THE STRUCTURE
FROM THE DEPTH DAMAGE TABLE
LEAST SQUARE LINE OF THE DAMAGE POINTS
INDIVIDUAL DAMAGE POINTS
0
20
40
60
80
100
120
140
160
VALUE OF STRUCTURE $1000's
DAMAGE AS A PERCENTAGE OF STRUCTURAL VALUE

Figure G-3



0.5 FT FIRST FLOOR FLOODING
WITH NO BASEMENT
DAMAGES AS A PERCENT OF STRUCTURAL VALUE VERSUS THE VALUE OF THE STRUCTURE
--- FROM THE DEPTH DAMAGE TABLES
O : HOUSES WITH NO BASEMENTS
X : SPLIT LEVELS INTERVIEWED FOR 2FT FIRST FLOOR FLOODING
O : SPLIT LEVELS INTERVIEWED FOR 8FT BASEMENT FLOODING
GRAPH #THREE
DAMAGE AS A PERCENTAGE OF STRUCTURAL VALUE
VALUE OF STRUCTURE $1000'S
0
20
40
60
80
100
120
140
160

Figure G-4

The relationship of damages as a percentage of structural value to the value of the structure for 2-foot first-floor flooding is shown in figure G-2. The residential depth-damage table defines a relationship which gives a damage percentage of about 65 percent of the structural value to a home valued at $5,000. Damages decrease to 50 percent of the structural value as the value increases to $18,000. Damages remain at 50 percent for all structures valued at more than $18,000. In the West Fargo interviews, the structure with the least value was worth $29,000. Therefore, the least squares line increases from damages valued at 48 percent of the structure at $29,000 to damages worth 58 percent of the structural value at $63,000. Within this range, the estimate from the depth-damage table is near the least squares line; if the least squares trend line continues to increase in the same direction, the two lines will diverge farther. House values on the residential depth-damage table extend to $50,000. After this point, the damage values are extrapolated using the same percentage used for homes with values of $50,000.

In figure G-3, the damage percentage versus the structural value relationship is determined for homes with 3-foot basement flooding. The relationship increases at a constant rate from 6.5 percent at $1,000 to 18 percent at $50,000. Again, for structural values greater than $50,000, the damage percentage is extended horizontally. The least squares regression line increases from a damage level of 18 percent at $28,000 to a level of 26 percent at $124,000. At no structural value is the damage percentage from the depth-damage table as great as the least squares line of the interview responses.

Figure G-4 shows the damage percentage from the depth-damage tables. The damages are approximately 27 percent of the structural value. A least squares line was not drawn on this graph because of the lack of data points. Houses with no basements have two damage points; the other damage points were split-levels. Owners of these split-levels were interviewed for 2-foot first-floor flooding and 3-foot basement flooding. These homes were not included in the first two graphs for two reasons. First, their damage percentages were different from the damages found in conventional homes with

basements and would prejudice the least squares lines on the first two graphs. Second, when their flood levels were estimated in 1976, they were listed as homes without basements. Split-levels show different damage levels than other styles of homes at the same value and flood level. In future considerations for the depth-damage table, it may be appropriate to have a separate damage relationship for split-levels.

Graphs similar to figures G-2 and G-3 would also be expected for other depths of flooding. Although the sample population is small, the two figures indicate that the St. Paul District standardized depth-damage tables significantly underestimate the damages caused by basement flooding and may underestimate the damage to average and higher valued homes that receive first-floor flooding. Further analysis of the sample population suggested a reason for this discrepancy. Of the 36 homes in the sample that had basements, 26 homes or 72 percent had basements which were partially or completely converted to additional living space. These modifications include such amenities as furniture, carpeting, stereo equipment, etc. - all things that are much more susceptible to damage. On the basis of the sample data, figure G-2, and more specific knowledge of the floodplain units gained from the interviews, the St. Paul District standardized depth-damage tables are not representative of West Fargo. Damages for basement flooding appear to be understated; however, because of the sample size no modifications have been made in the elevation-damage relationship curves for the West Fargo-Riverside area. A comparison of damages used in the current analysis for the base floods with damages indicated by sample information is given in table G-34.

Table G-34 - West Fargo's damages using the St. Paul District depth-damage table

Category	Damages ($1,000)		
	1965 flood - 2 feet	1965 flood	1965 flood + 2 feet
Residential			
Direct first-floor flooding(1)	12,384	22,965	30,959
Direct basement flooding	12,284	15,444	19,078
Indirect	2,642	899	14
Total	27,310	39,308	50,051

(1) Mobile homes, multifamily homes, and public housing were interviewed and assumed not to change.

If the sample information were representative, our standardized estimates for basement flooding would be approximately 3 to 17 percent less than if we had interviewed each homeowner individually. Assuming a median estimate of an 11-percent increase, damages for the base flood would be adjusted in the following manner.

Table G-35 - Residential damages with basement damage adjustment of 11 percent[1]

Category	Damages ($1,000)		
	1965 flood - 2 feet	1965 flood	1965 flood + 2 feet
Residential			
Direct first-floor flooding	12,384	22,965	30,959
Direct basement flooding	13,635	17,143	21,177
Indirect	2,933	998	16
Total	28,952	41,106	52,152

(1) October 1980 prices.

This modification increased total residential damages for the base floods from $39,308,000 to $41,106,000 or by 4.6 percent. Total damages for a recurrence of the 1965 flood would be increased by 4 percent.

WATER SURFACE PROFILE - WEST FARGO

The 1965 water surface profile was selected to represent the base flood to assess damages. A sensitivity check on a 57-percent residential sample was done using the water surface profiles of the 1969, 1978, and 1979 floods. Both the 1969 and 1979 floods were similar to the 1965 flood; they had high Sheyenne River flows in addition to high backwater effects from the Maple and Red Rivers. The 1978 flood differed in that flows on the Sheyenne River were very low but backwater from the Maple and Red Rivers was high and stage readings at the West Fargo USGS gage were high. The hydraulic relationships of these floods to various reference river miles are summarized in Appendix C.

Table G-36 gives the difference between the USGS gage height at West Fargo and the referenced river mile.

Table G-36 - Elevations at referenced river miles

River mile	Elevation [1] 1965 flood (17% chance)	1969 flood (7% chance)	1978 flood (12.5% chance)	1979 flood (5% chance)
24.5 (USGS gage)	898.0	899.0	898.3	899.4
26.25	+2.2	+1.6	+1.0	+1.9
27.4	+3.0	+3.0	+2.6	+3.2
27.9	+3.6	+3.3	+3.1	+4.0
28.5	+4.2	+4.0	+3.3	+4.6
29.6	+5.5	+5.2	+4.6	+5.2

(1) Feet msl.

Each profile was evaluated using a base gage elevation of 898.0. The changes at the various reference points reflect the changes in elevation shown above for the respective floods. A computer run was made correlating depth of flooding indicated by each of the profiles with the St. Paul District residential depth damage tables for the sample homes. The results of the sample run should indicate changes in total damages for the urban area. Damages for the base flood and two variations of the base flood are shown in the following table.

Table G-37 - Damages to sample residences using the different water surface profiles[1]

Water surface profile	Damages: Base flood (898.0 at West Fargo gage)	Percent of 1965 profile damages	Base flood plus 1 foot	Percent of 1965 plus 1-foot profile damages	Base flood minus 2 feet	Percent of 1965 minus 2-foot profile damages
1965	$16,472,000	100	$18,523,000	100	$11,750,000	100
1969	16,109,000	98	18,158,000	98	11,100,000	94
1978	15,086,000	92	17,193,000	93	9,603,000	82
1979	16,604,000	101	18,811,000	102	11,958,000	102

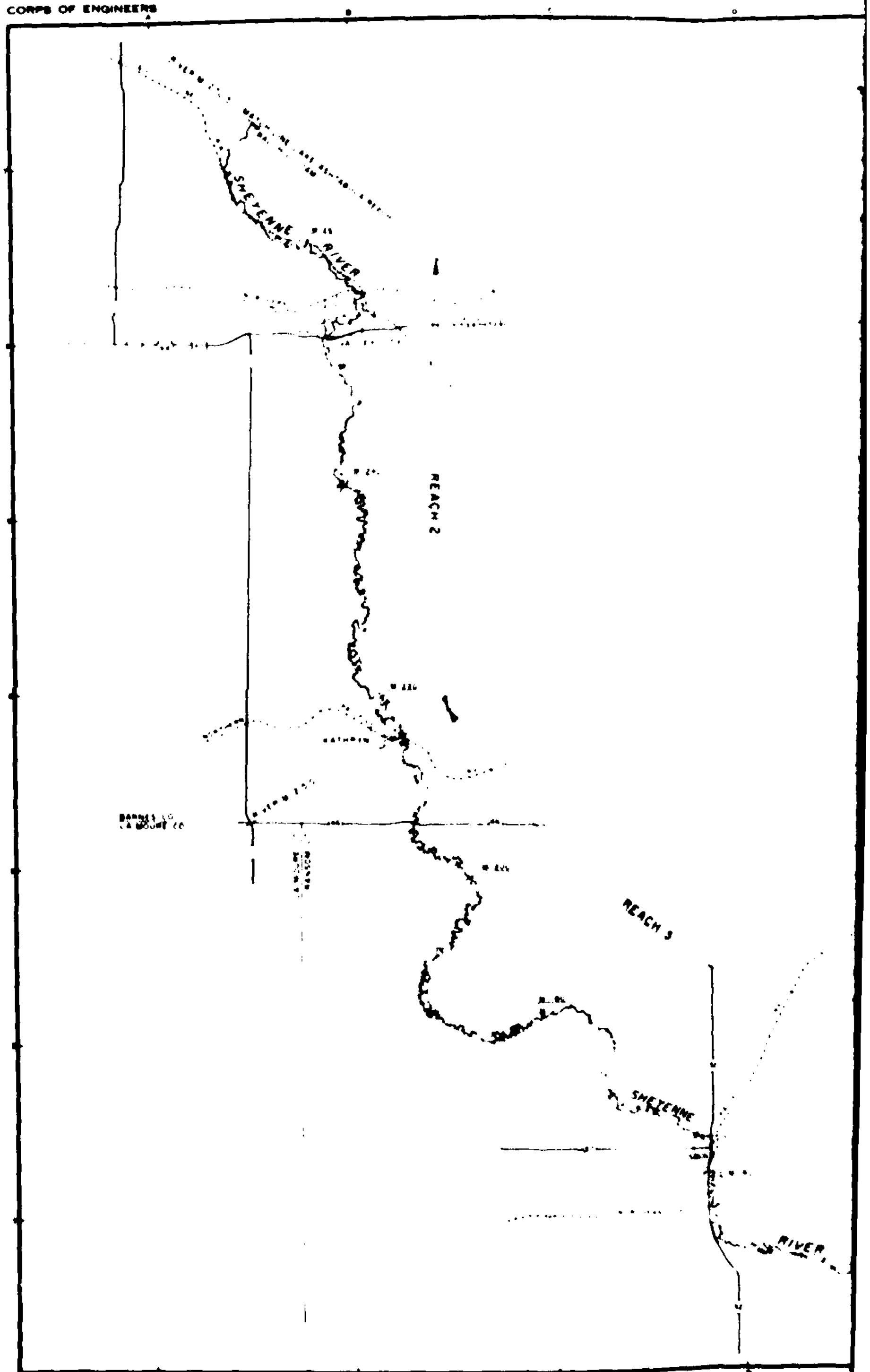
(1) October 1980 prices.

The 1965 profile is fairly representative of the 1969 and 1979 events. Damage for the 1978 event would be overstated using the 1965 profile. This situation would result for any event in which there was little or no flow down the Sheyenne River and substantial backwater from the Maple and Red Rivers. Because of climatological conditions, these rivers generally flood about the same time and at the same magnitude. Therefore, the 1965 event is more representative of the "typical" flood situation in West Fargo.

EFFECTIVENESS OF EMERGENCY LEVEES AT WEST FARGO

If the levees are assumed certifiable, they could be assumed to protect up to within 3 feet of the top elevation. The maximum emergency levee height at West Fargo is approximately 5 feet above natural ground elevation. Using the assumption of certifiability and holding the other assumptions constant, the levees would protect to an elevation of 899.5 or against the 4.5-percent frequency flow. Average annual damages under these conditions would be $3,874,000. Total benefits for the recommended plan at 7 5/8-percent interest would be $6,682,000. The benefit-cost ratio is 1.83.

CORPS OF ENGINEERS



U S ARMY

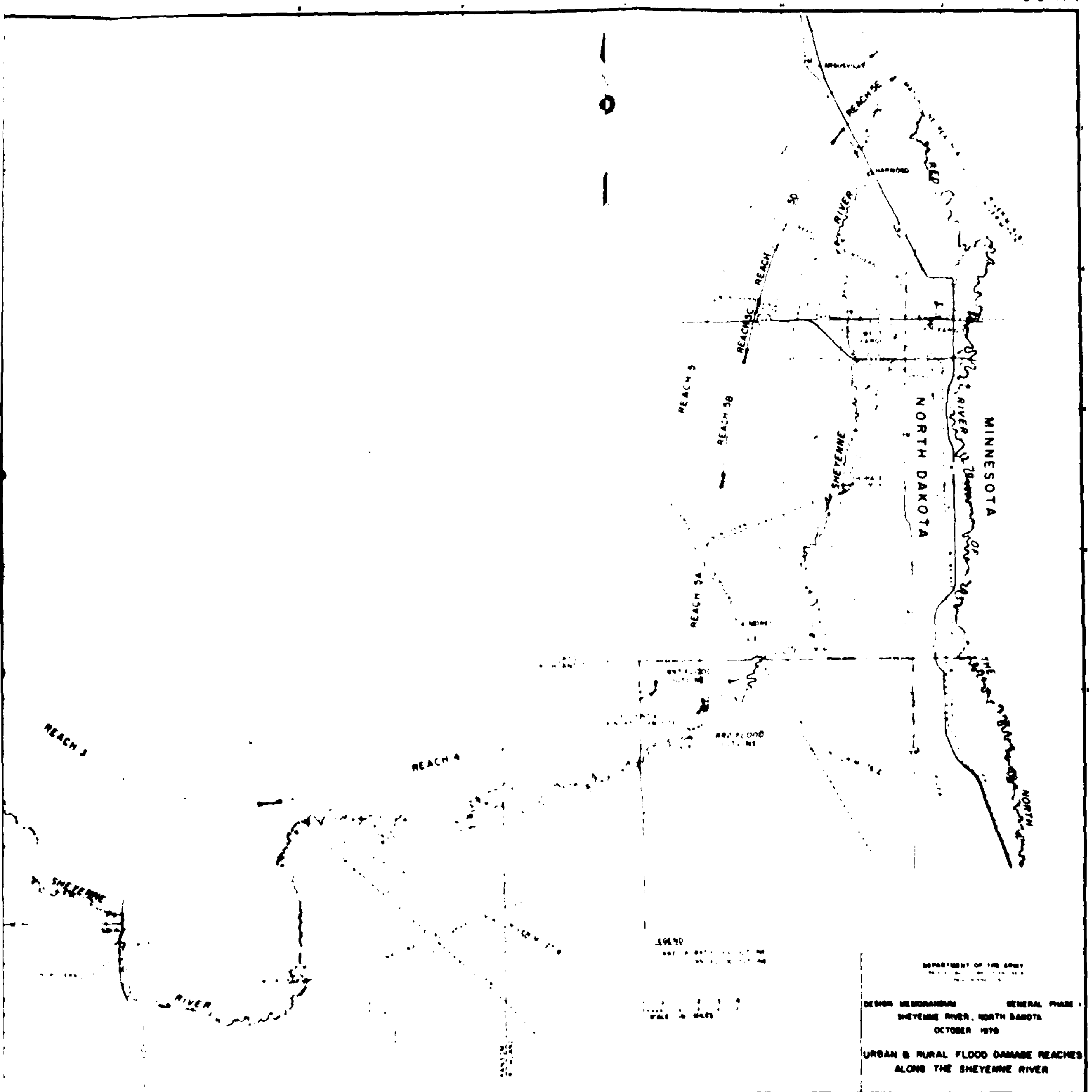
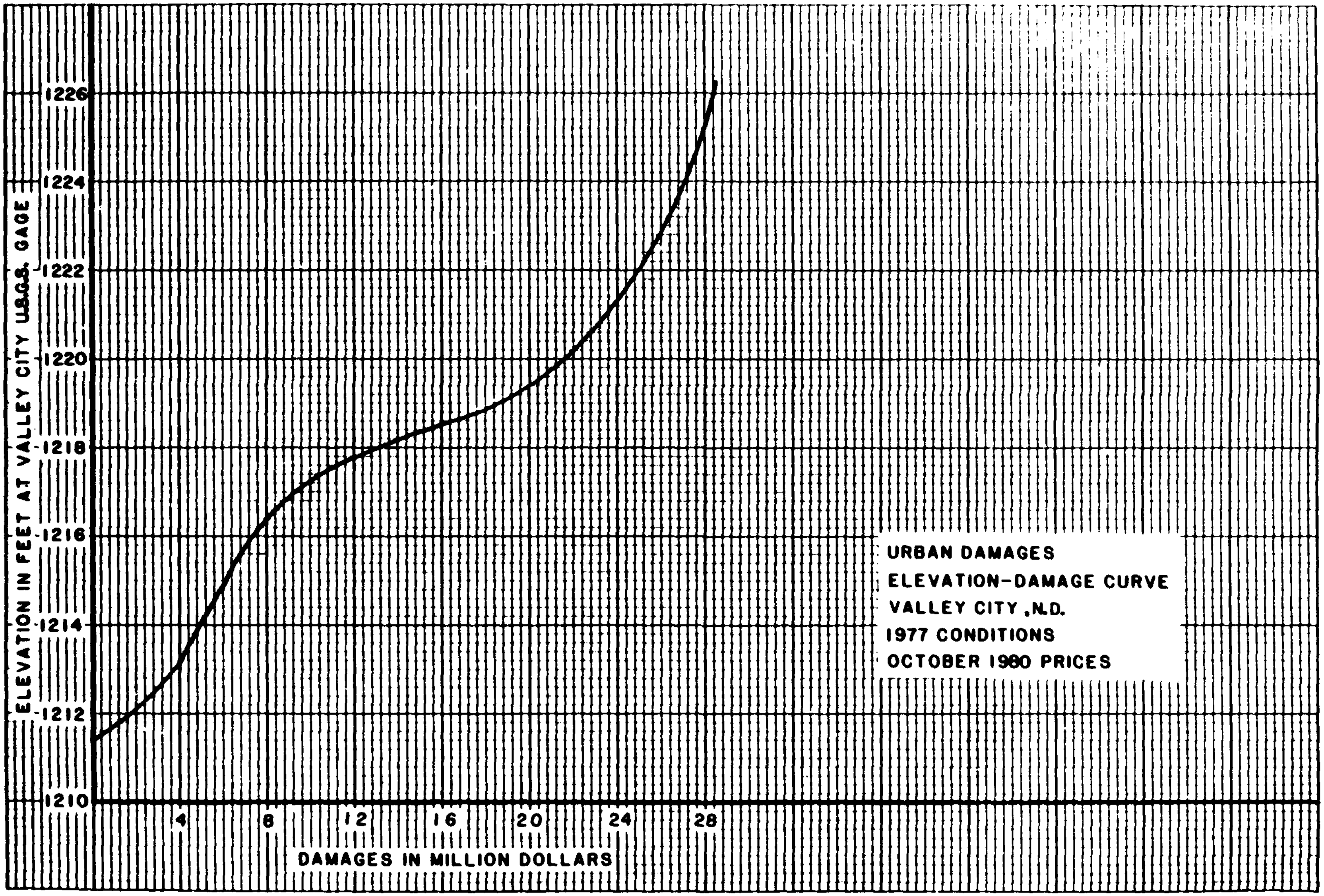
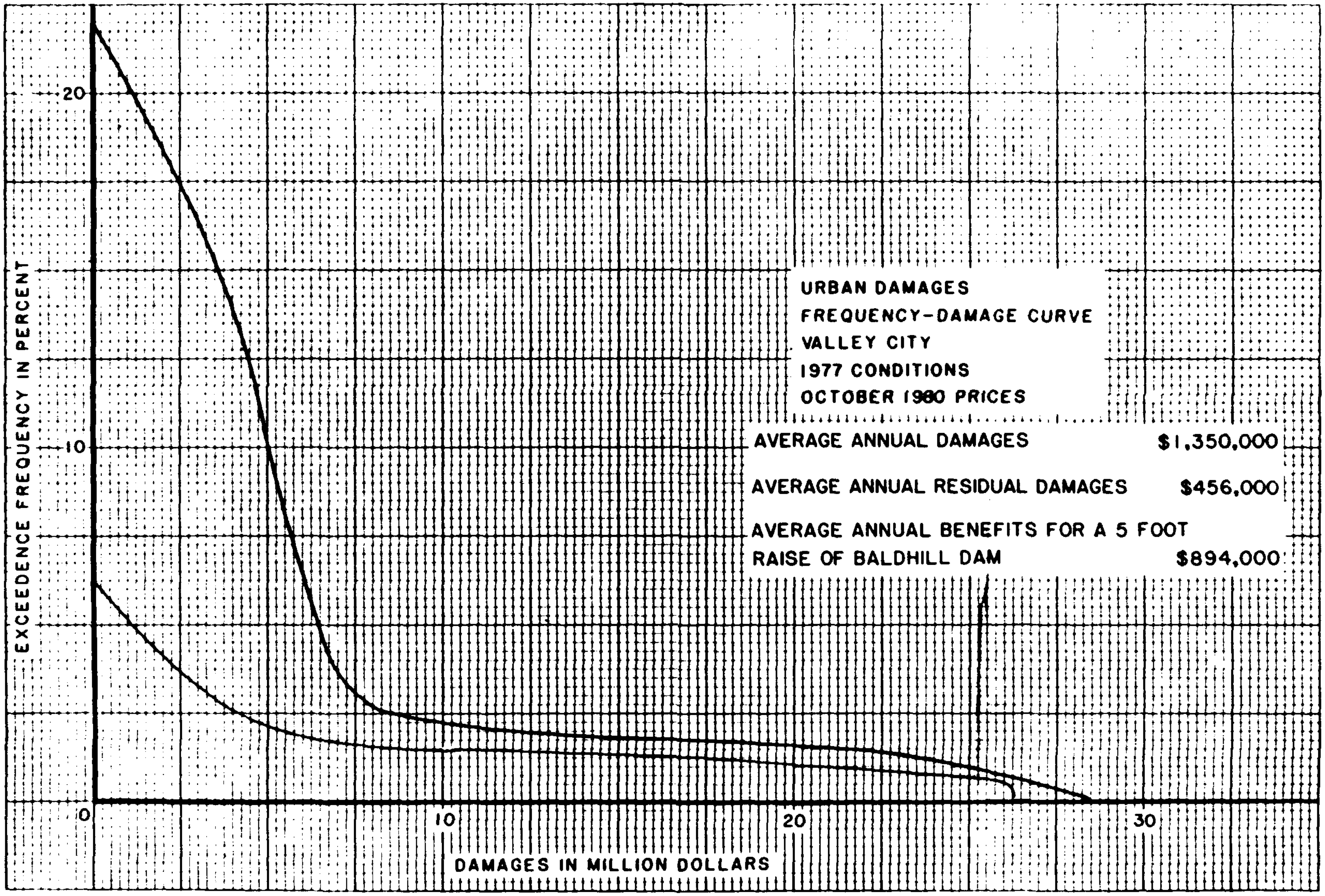


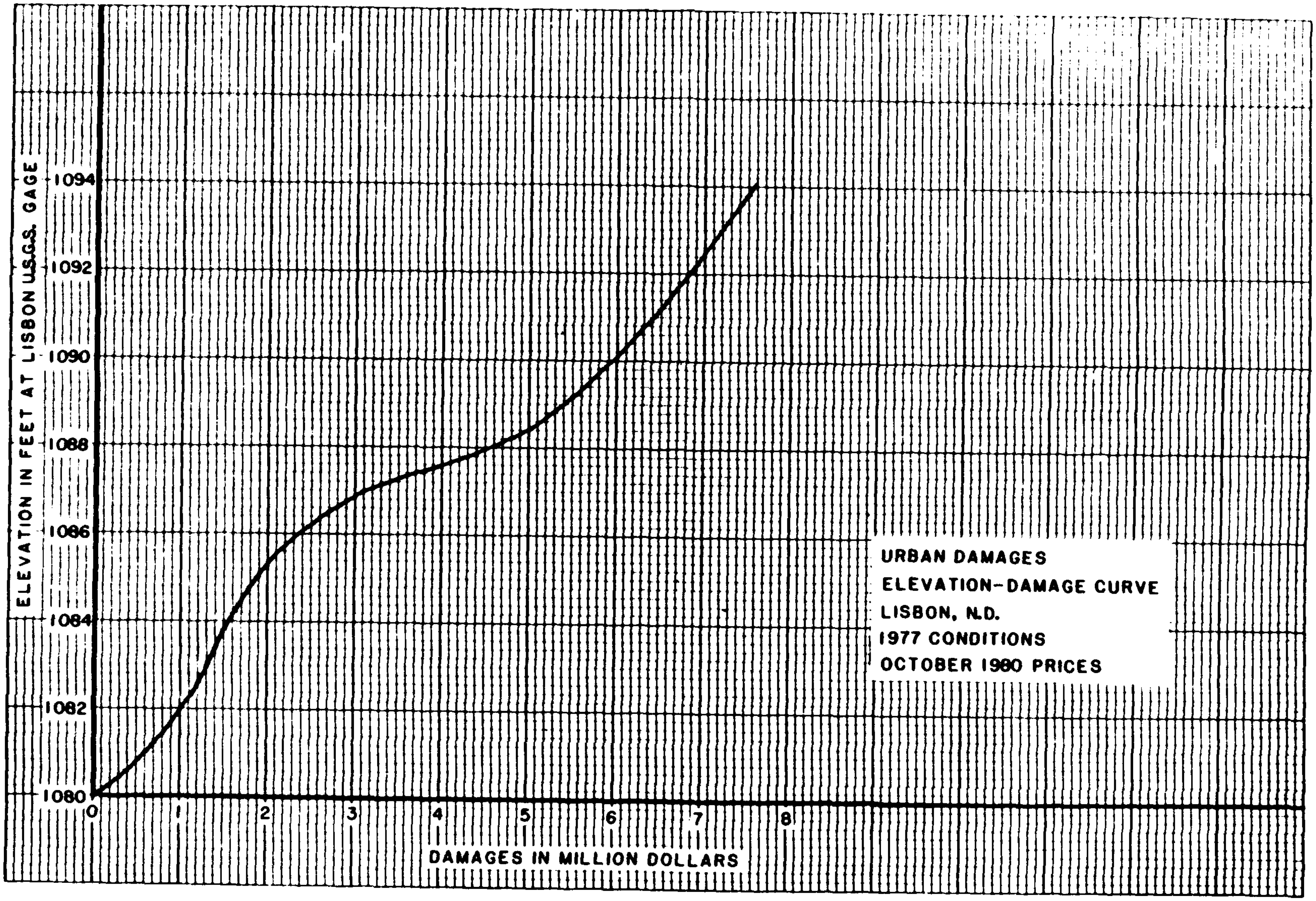
PLATE G-1



URBAN DAMAGES
ELEVATION-DAMAGE CURVE
VALLEY CITY, N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT VALLEY CITY U.S.G.S. GAGE
1210
1212
1214
1216
1218
1220
1222
1224
1226
4
8
12
16
20
24
28
DAMAGES IN MILLION DOLLARS

PLATE G-2


URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
VALLEY CITY
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $1,350,000
AVERAGE ANNUAL RESIDUAL DAMAGES $456,000
AVERAGE ANNUAL BENEFITS FOR A 5 FOOT
RAISE OF BALDHILL DAM $894,000
EXCEEDENCE FREQUENCY IN PERCENT
20
10
0
10
20
30
DAMAGES IN MILLION DOLLARS


URBAN DAMAGES
ELEVATION-DAMAGE CURVE
LISBON, N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT LISBON U.S.G.S. GAGE
1080
1082
1084
1086
1088
1090
1092
1094
0
1
2
3
4
5
6
7
8
DAMAGES IN MILLION DOLLARS

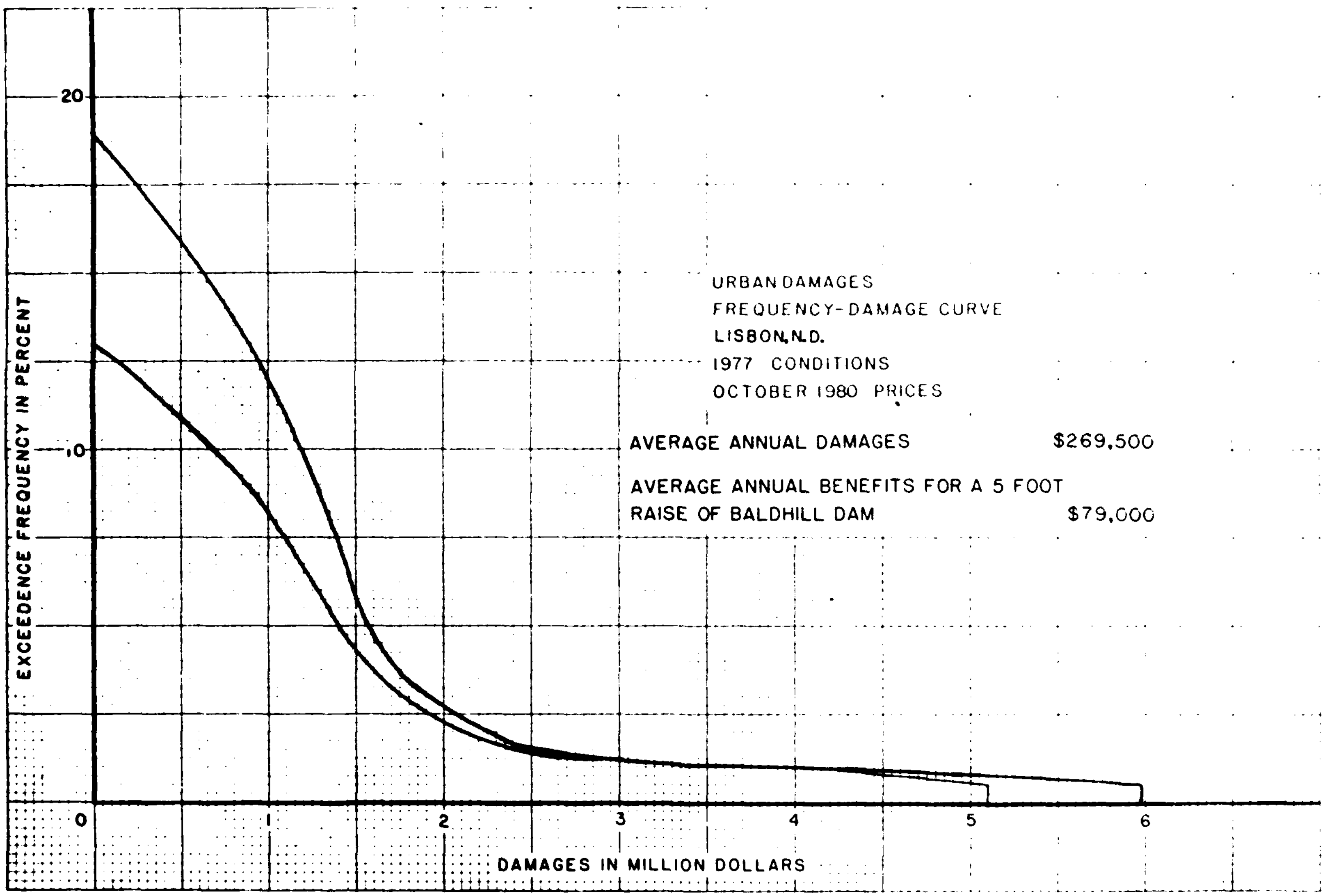

URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
LISBON, N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $269,500
AVERAGE ANNUAL BENEFITS FOR A 5 FOOT
RAISE OF BALDHILL DAM $79,000
EXCEEDENCE FREQUENCY IN PERCENT
20
10
0
1
2
3
4
5
6
DAMAGES IN MILLION DOLLARS

PLATE G-5

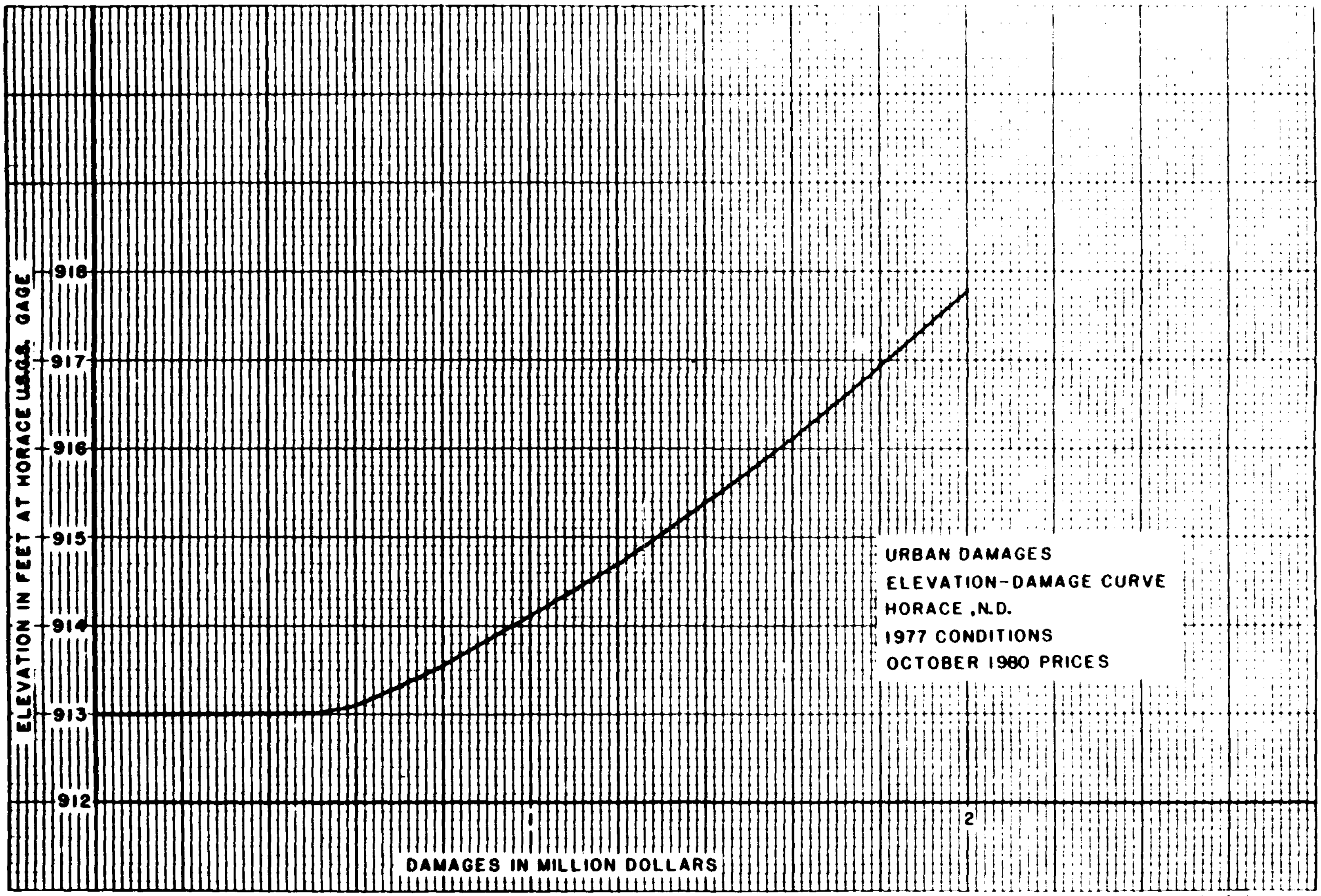

URBAN DAMAGES
ELEVATION-DAMAGE CURVE
HORACE ,N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT HORACE U.S.G.S. GAGE
918
917
916
915
914
913
912
1
2
DAMAGES IN MILLION DOLLARS

PLATE G-6

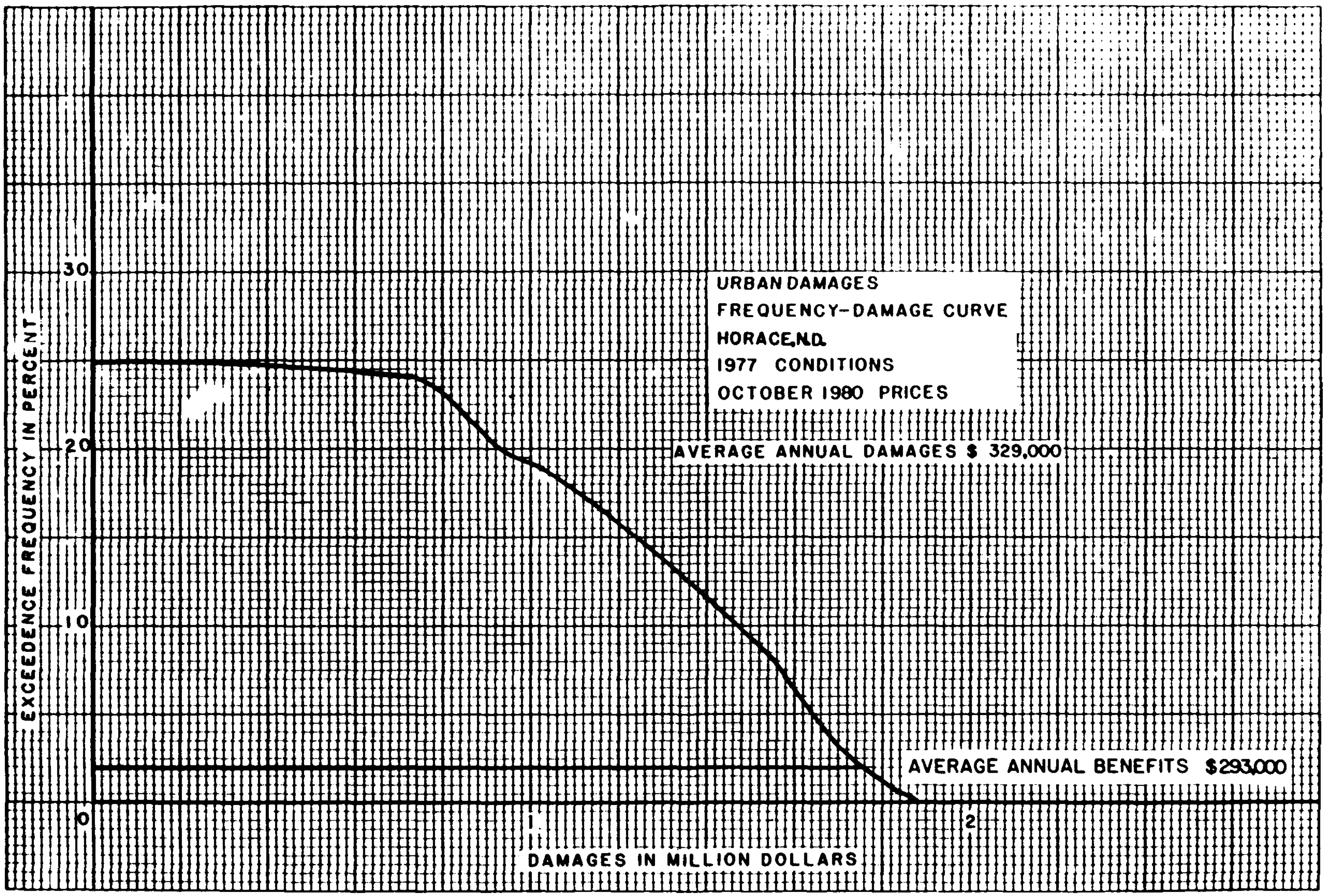

URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
HORACE,N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $ 329,000
AVERAGE ANNUAL BENEFITS $293,000
EXCEEDENCE FREQUENCY IN PERCENT
30
20
10
0
1
2
DAMAGES IN MILLION DOLLARS

PLATE G-7

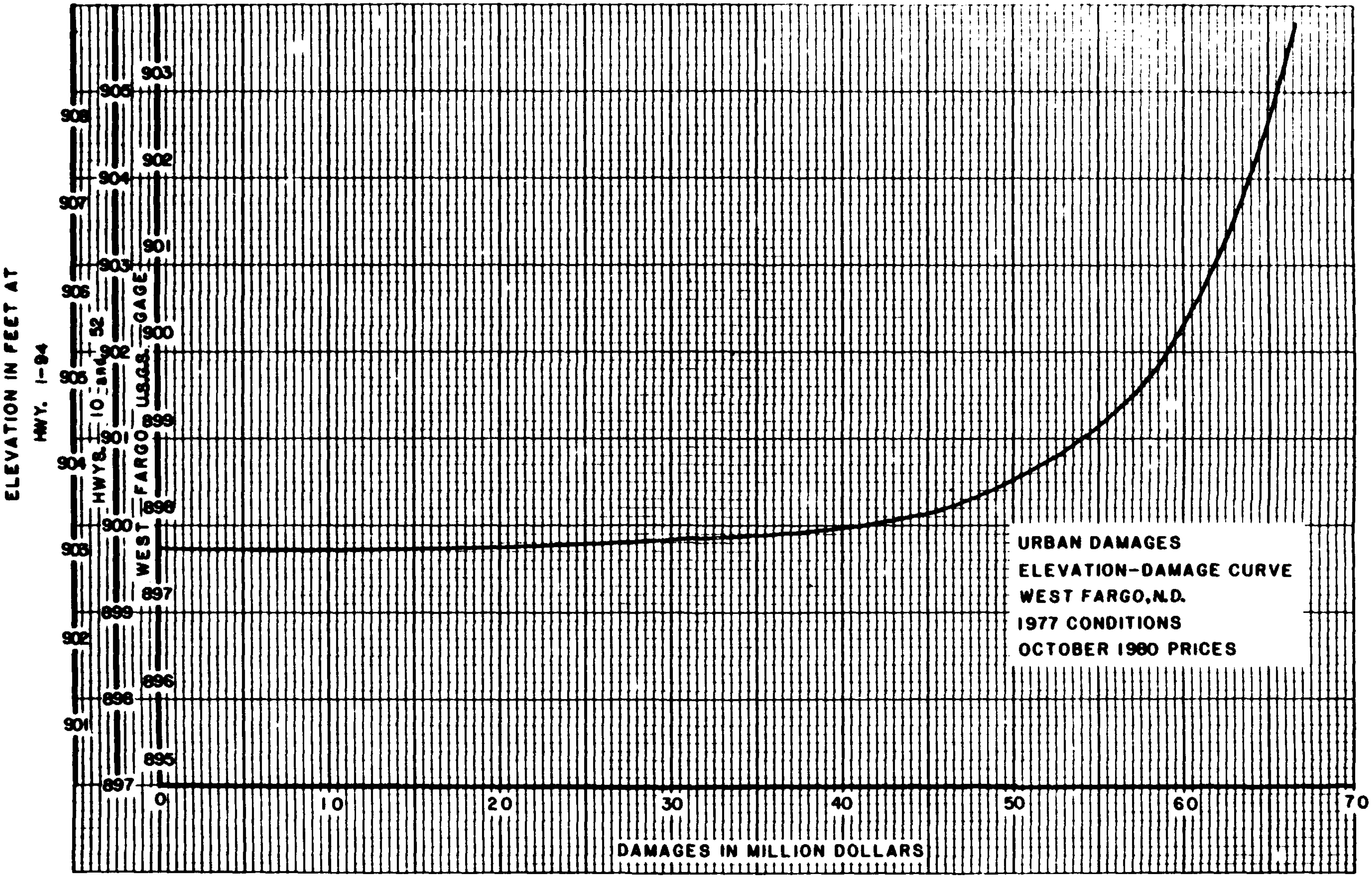
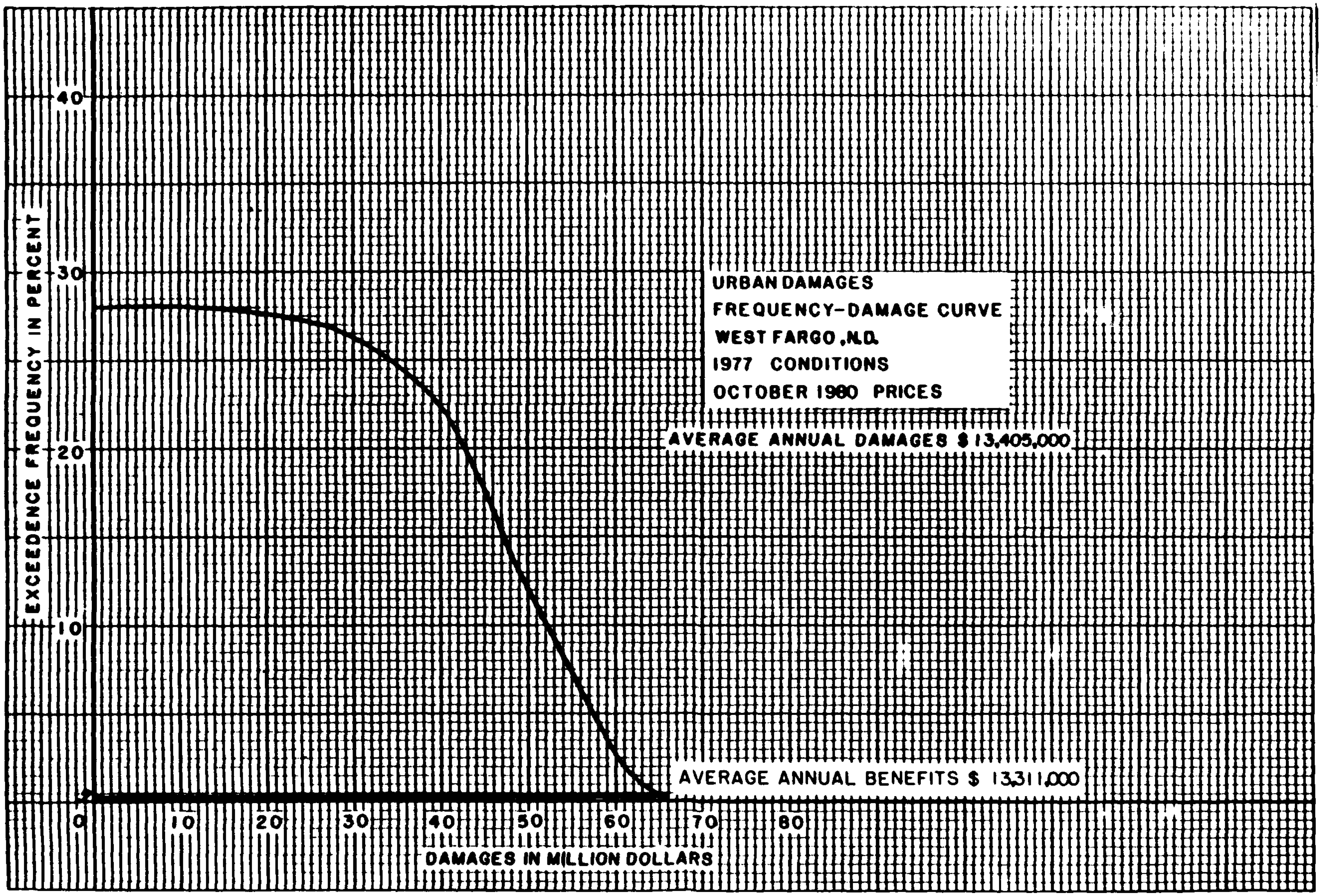
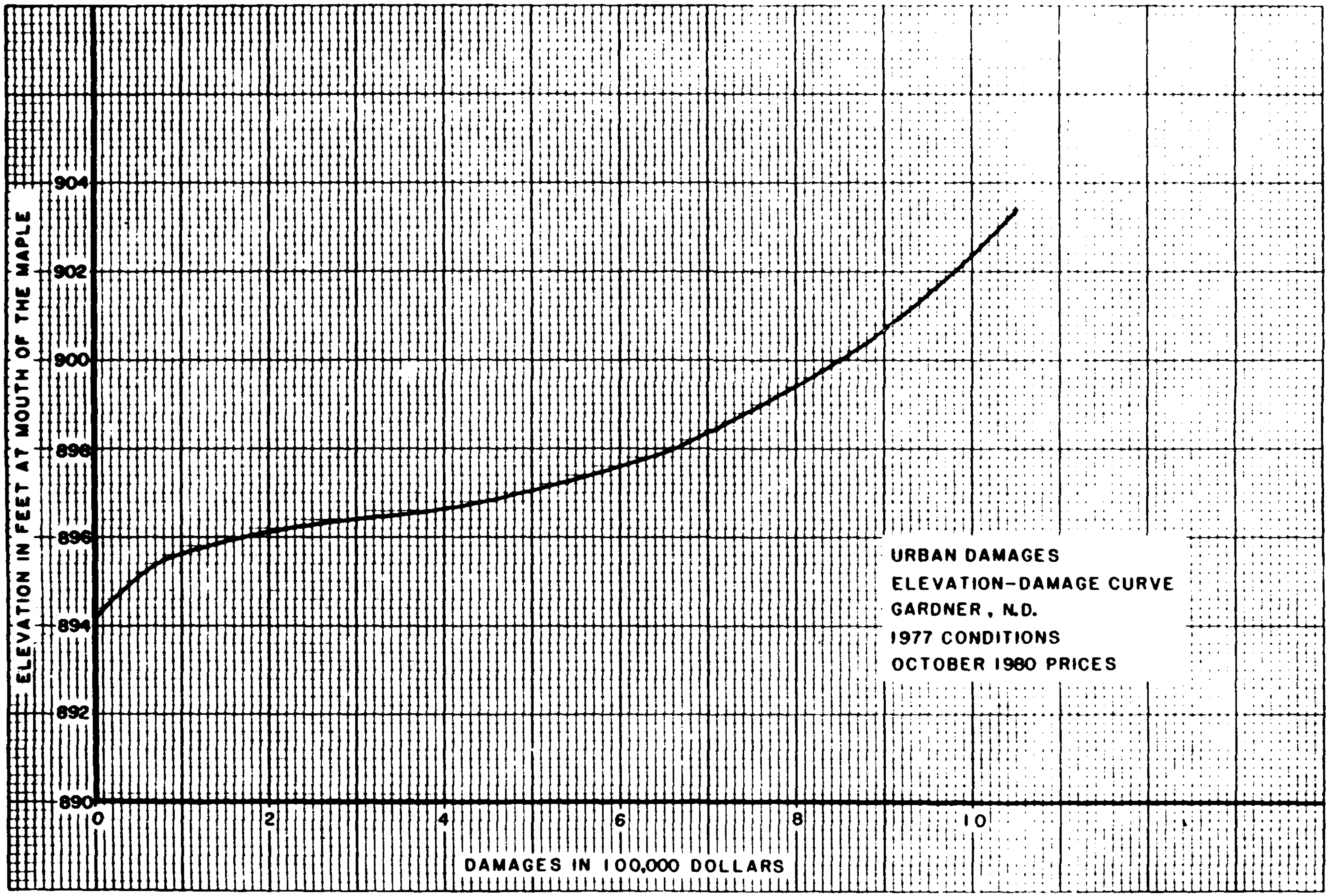
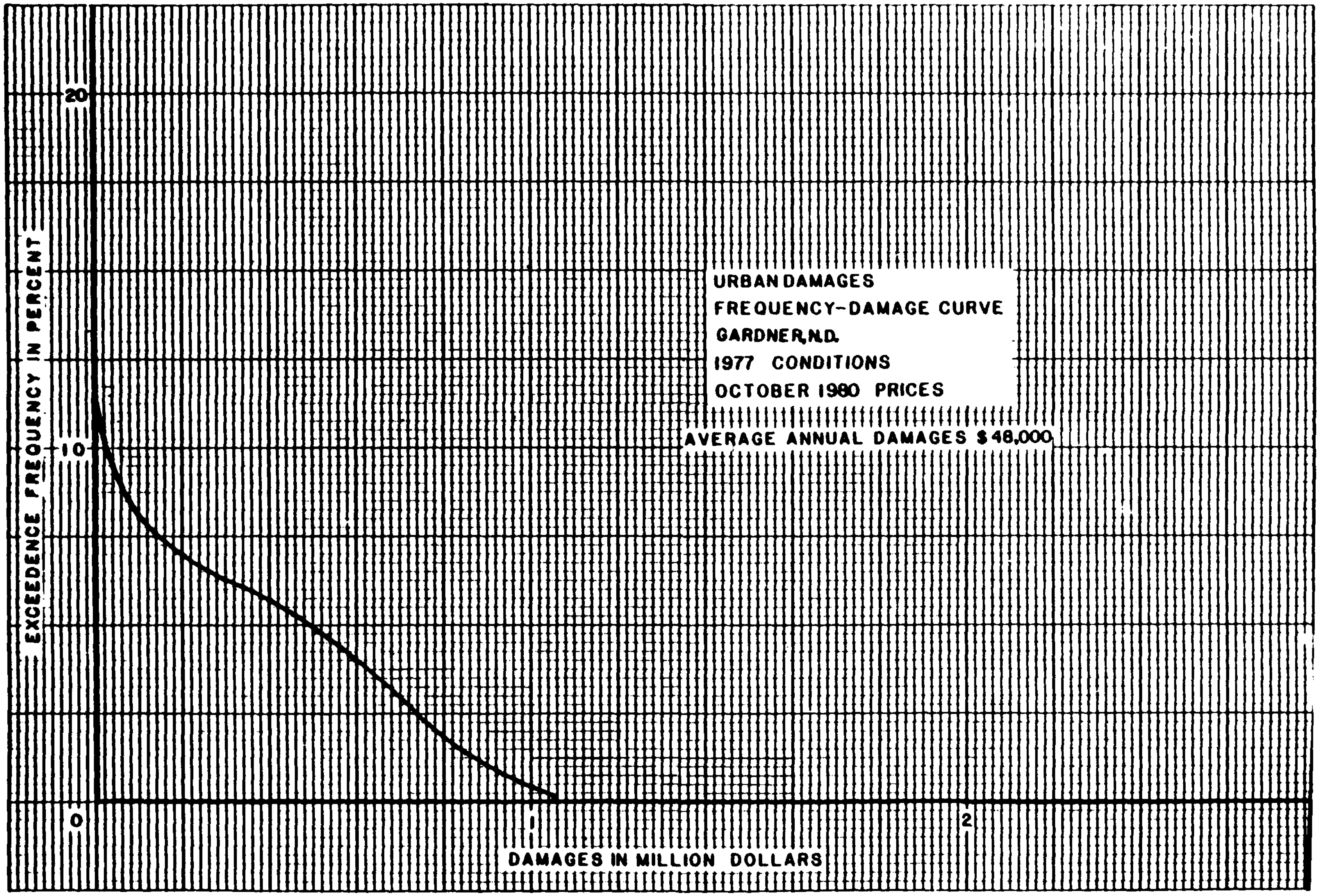

URBAN DAMAGES
ELEVATION-DAMAGE CURVE
WEST FARGO, N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT
HWY. I-94
HWYS. 10 and 52
WEST FARGO U.S.G.S. GAGE
908
907
906
905
904
903
902
901
905
904
903
902
901
900
899
898
897
903
902
901
900
899
898
897
896
895
0
10
20
30
40
50
60
70
DAMAGES IN MILLION DOLLARS

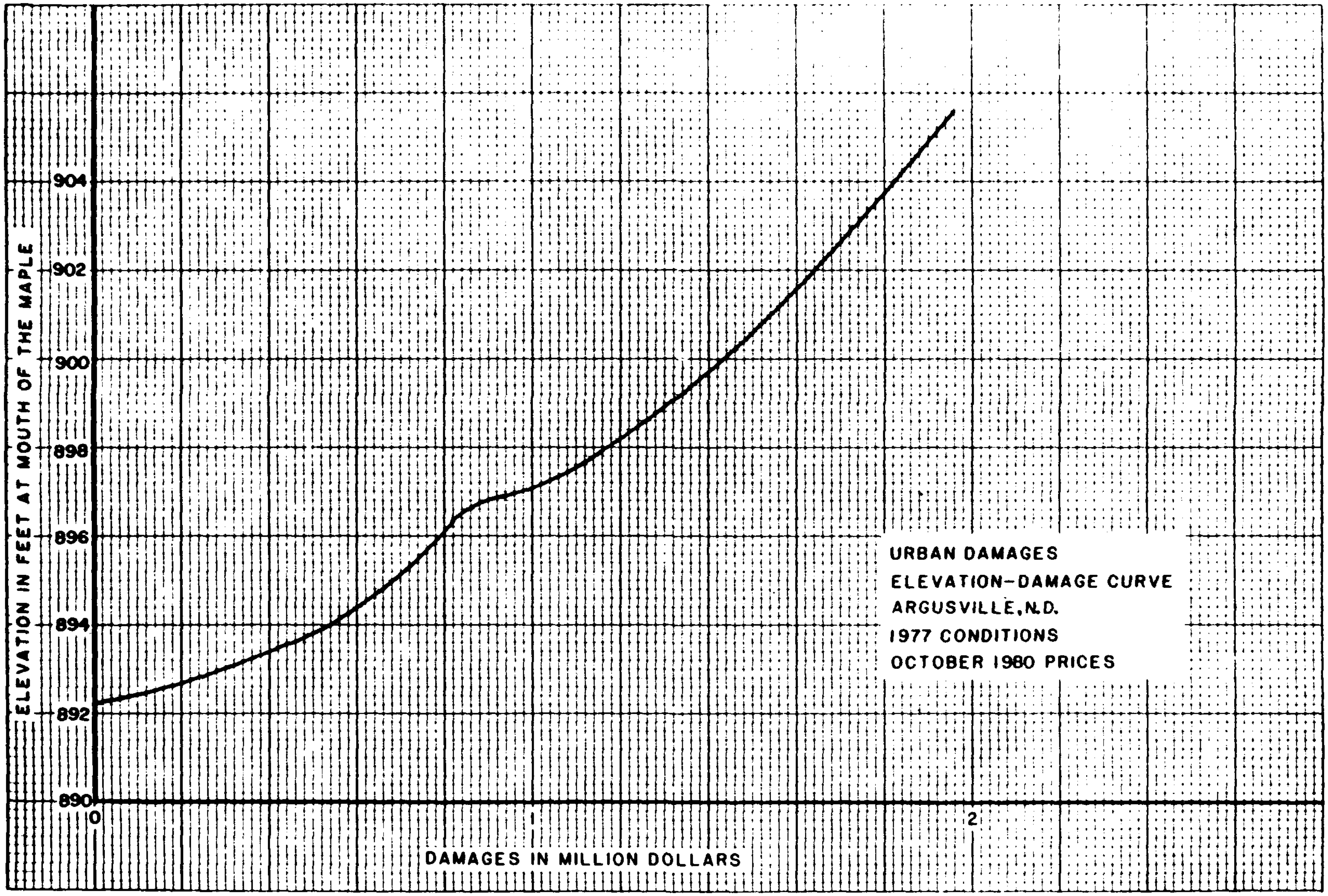
PLATE G-8


URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
WEST FARGO, N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $ 13,405,000
AVERAGE ANNUAL BENEFITS $ 13,311,000
EXCEEDENCE FREQUENCY IN PERCENT
40
30
20
10
0
10
20
30
40
50
60
70
80
DAMAGES IN MILLION DOLLARS


URBAN DAMAGES
ELEVATION-DAMAGE CURVE
GARDNER, N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT MOUTH OF THE MAPLE
904
902
900
898
896
894
892
890
0
2
4
6
8
10
DAMAGES IN 100,000 DOLLARS



URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
GARDNER, N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $48,000
EXCEEDENCE FREQUENCY IN PERCENT
20
10
0
1
2
DAMAGES IN MILLION DOLLARS


URBAN DAMAGES
ELEVATION-DAMAGE CURVE
ARGUSVILLE, N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT MOUTH OF THE MAPLE
904
902
900
898
896
894
892
890
0
1
2
DAMAGES IN MILLION DOLLARS

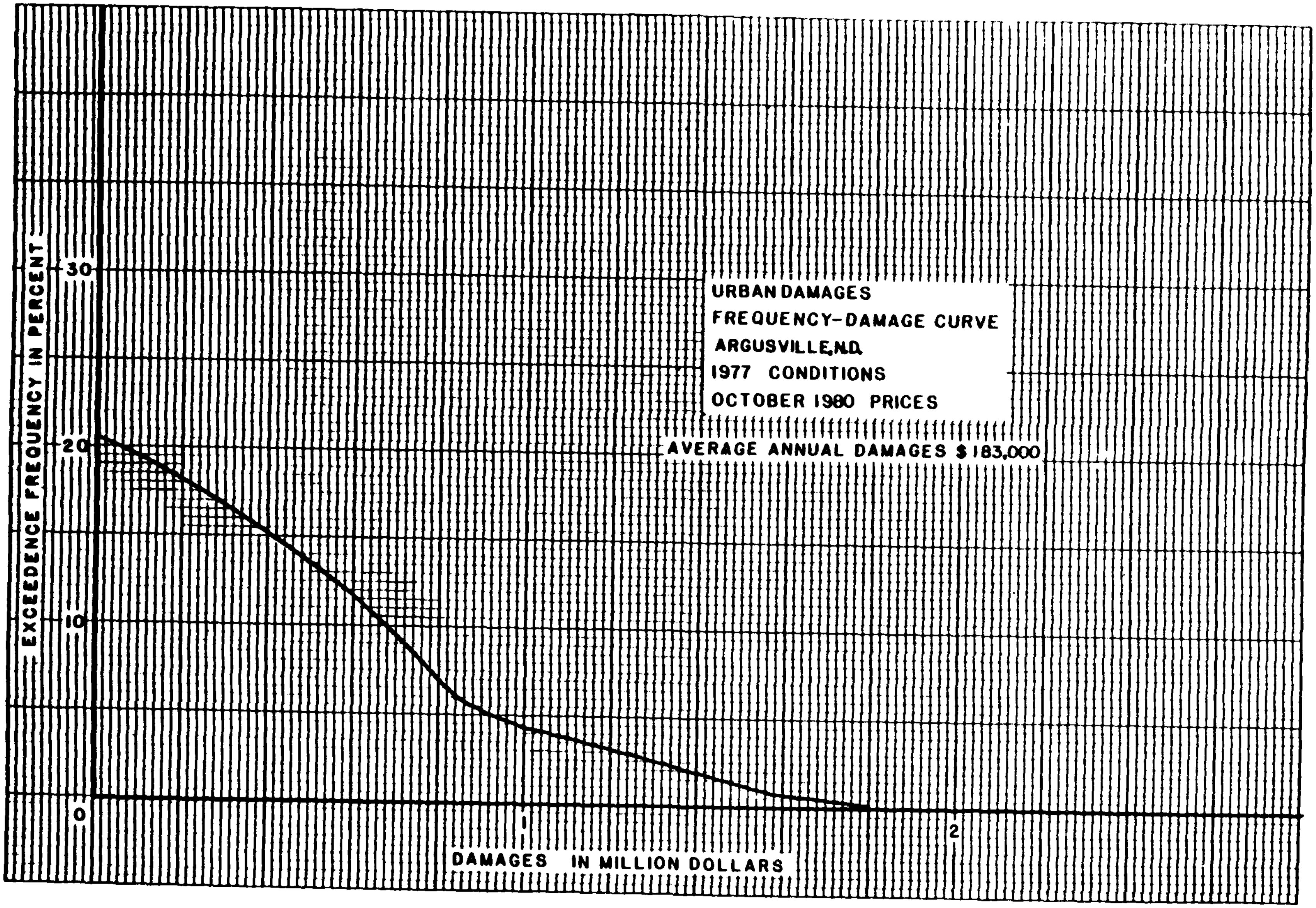

URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
ARGUSVILLE, N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $183,000
EXCEEDENCE FREQUENCY IN PERCENT
30
20
10
0
1
2
DAMAGES IN MILLION DOLLARS

PLATE G-13

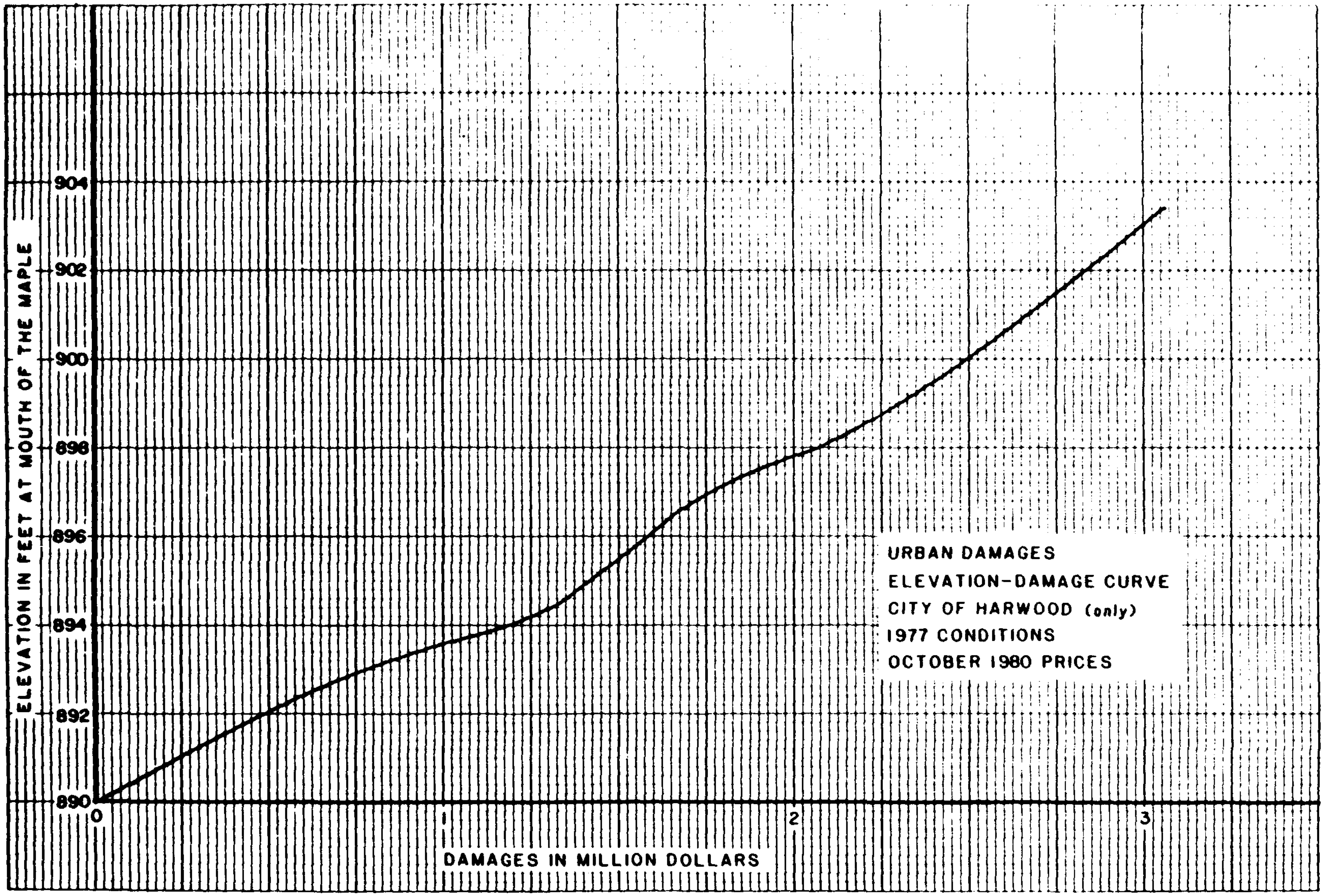
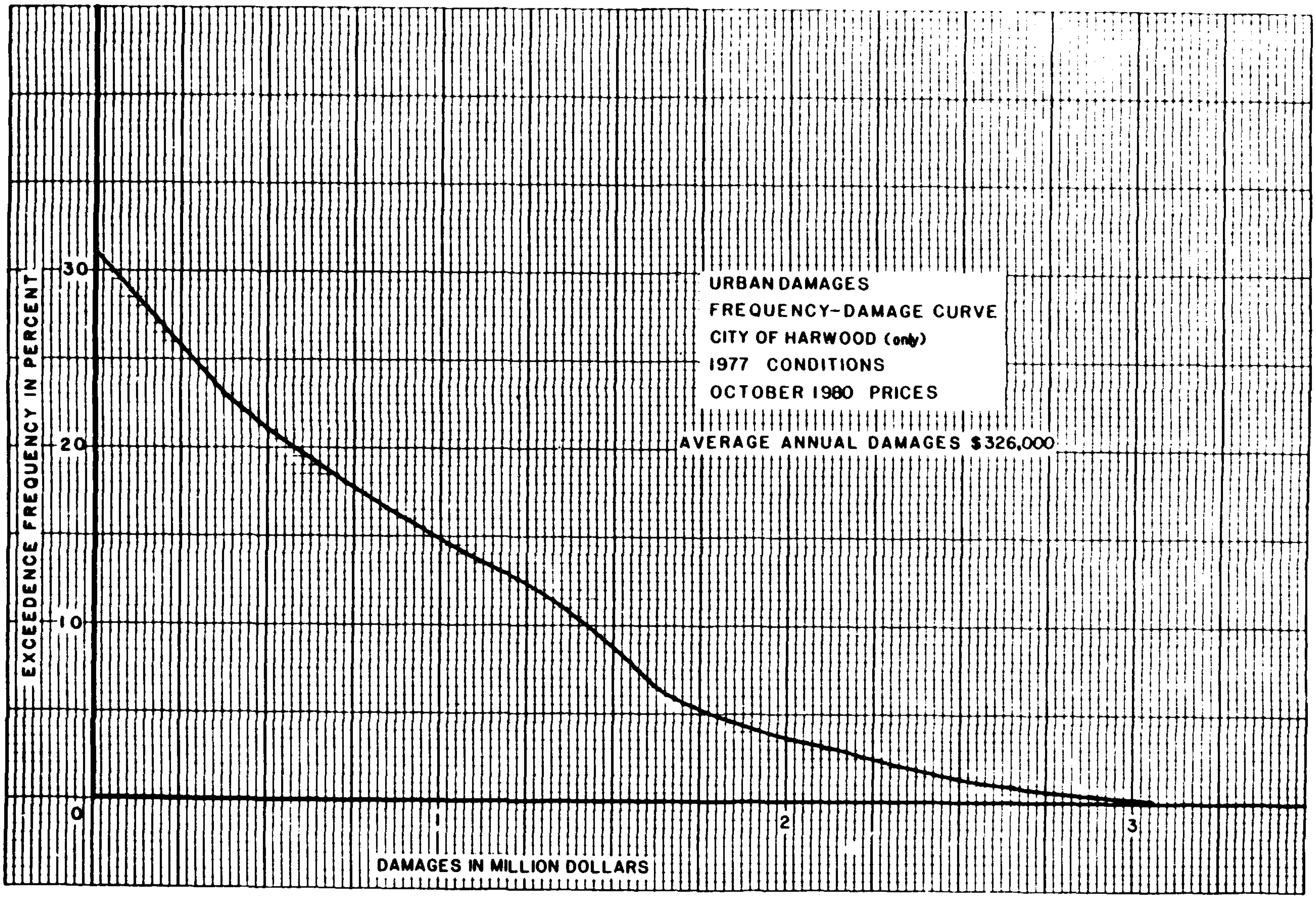
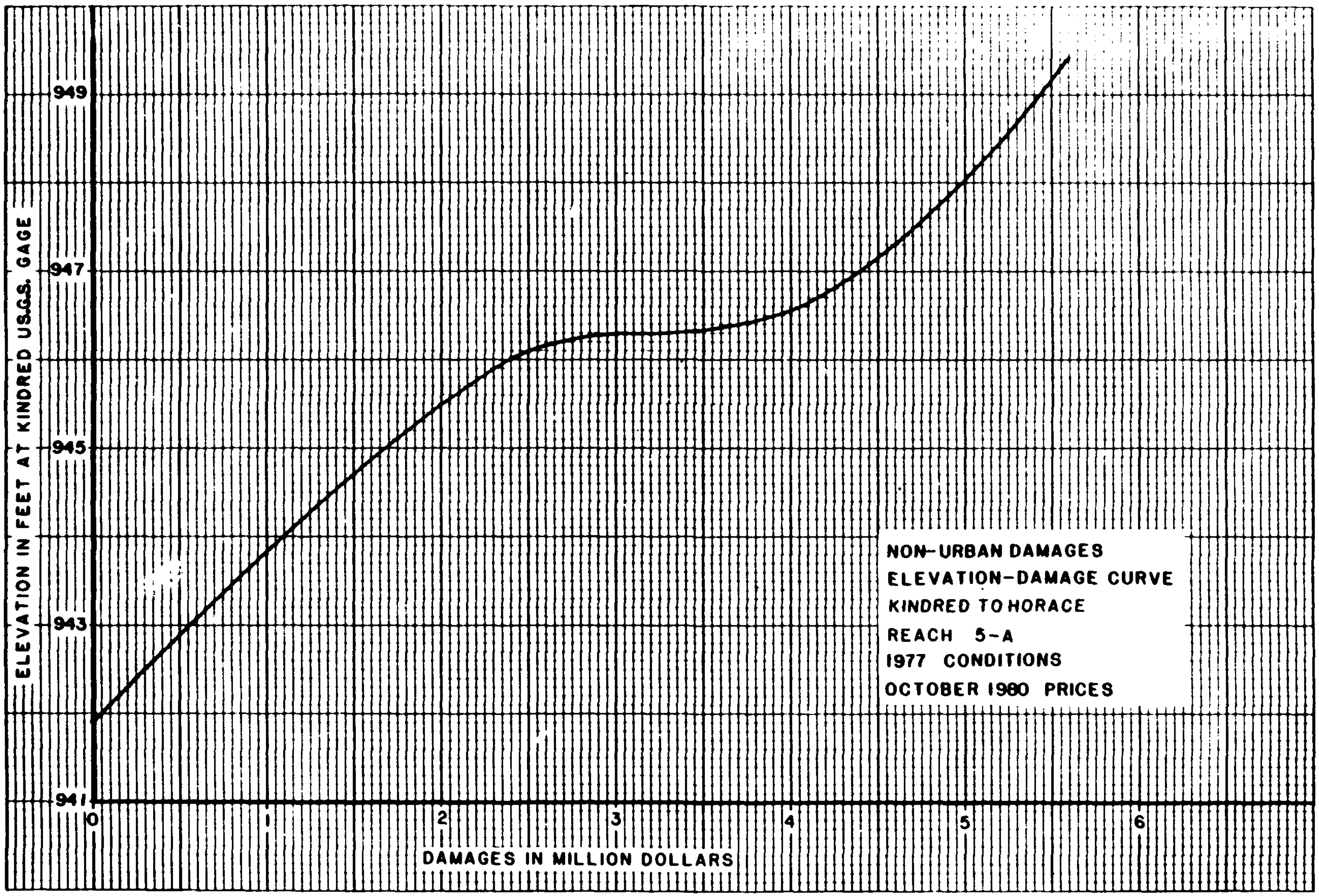
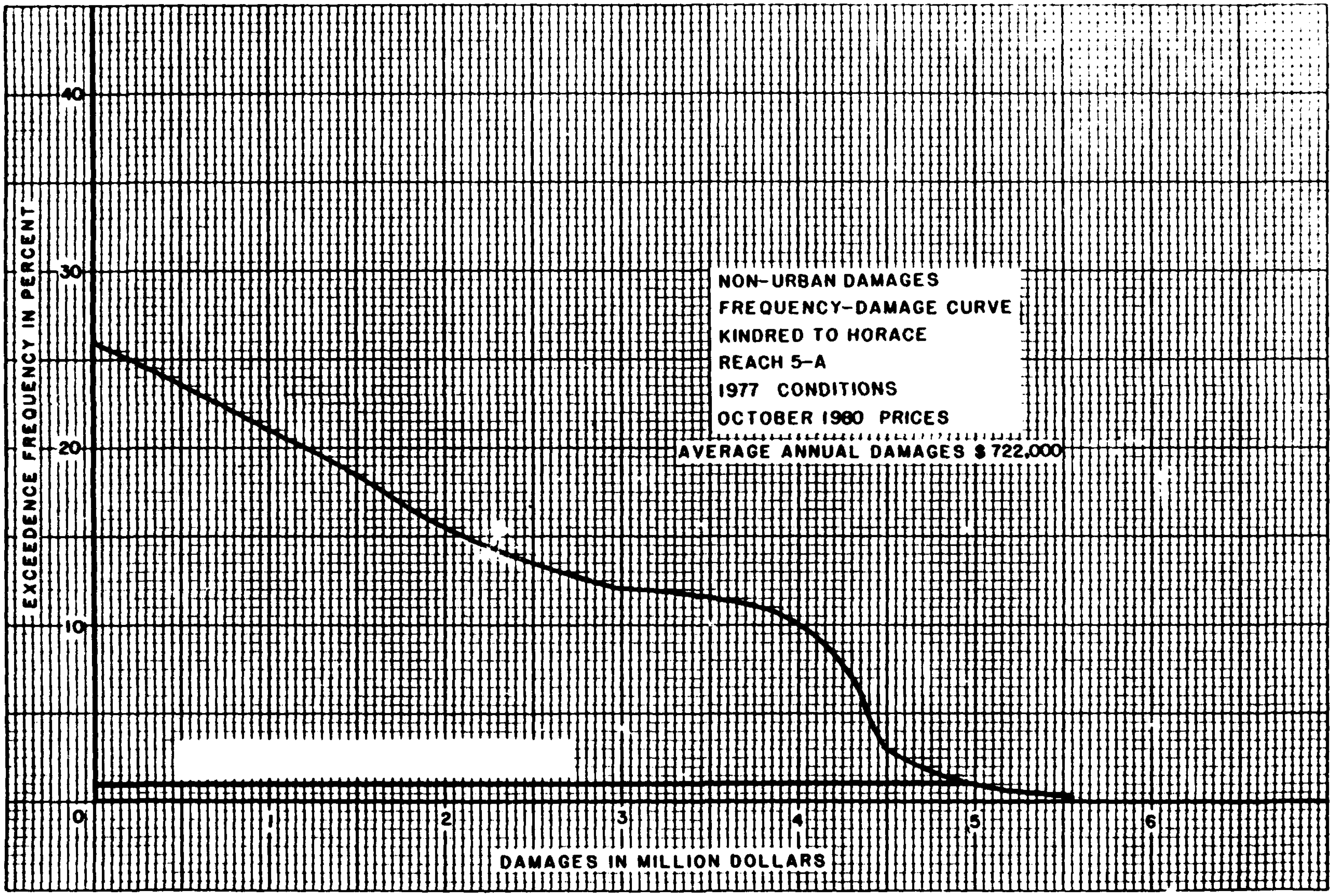

URBAN DAMAGES
ELEVATION-DAMAGE CURVE
CITY OF HARWOOD (only)
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT MOUTH OF THE MAPLE
904
902
900
898
896
894
892
890
0
1
2
3
DAMAGES IN MILLION DOLLARS

PLATE G-14


URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
CITY OF HARWOOD (only)
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $326,000
EXCEEDENCE FREQUENCY IN PERCENT
30
20
10
0
1
2
3
DAMAGES IN MILLION DOLLARS


NON-URBAN DAMAGES
ELEVATION-DAMAGE CURVE
KINDRED TO HORACE
REACH 5-A
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT KINDRED U.S.G.S. GAGE
949
947
945
943
941
0
1
2
3
4
5
6
DAMAGES IN MILLION DOLLARS


NON-URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
KINDRED TO HORACE
REACH 5-A
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $ 722,000
EXCEEDENCE FREQUENCY IN PERCENT
40
30
20
10
0
1
2
3
4
5
6
DAMAGES IN MILLION DOLLARS

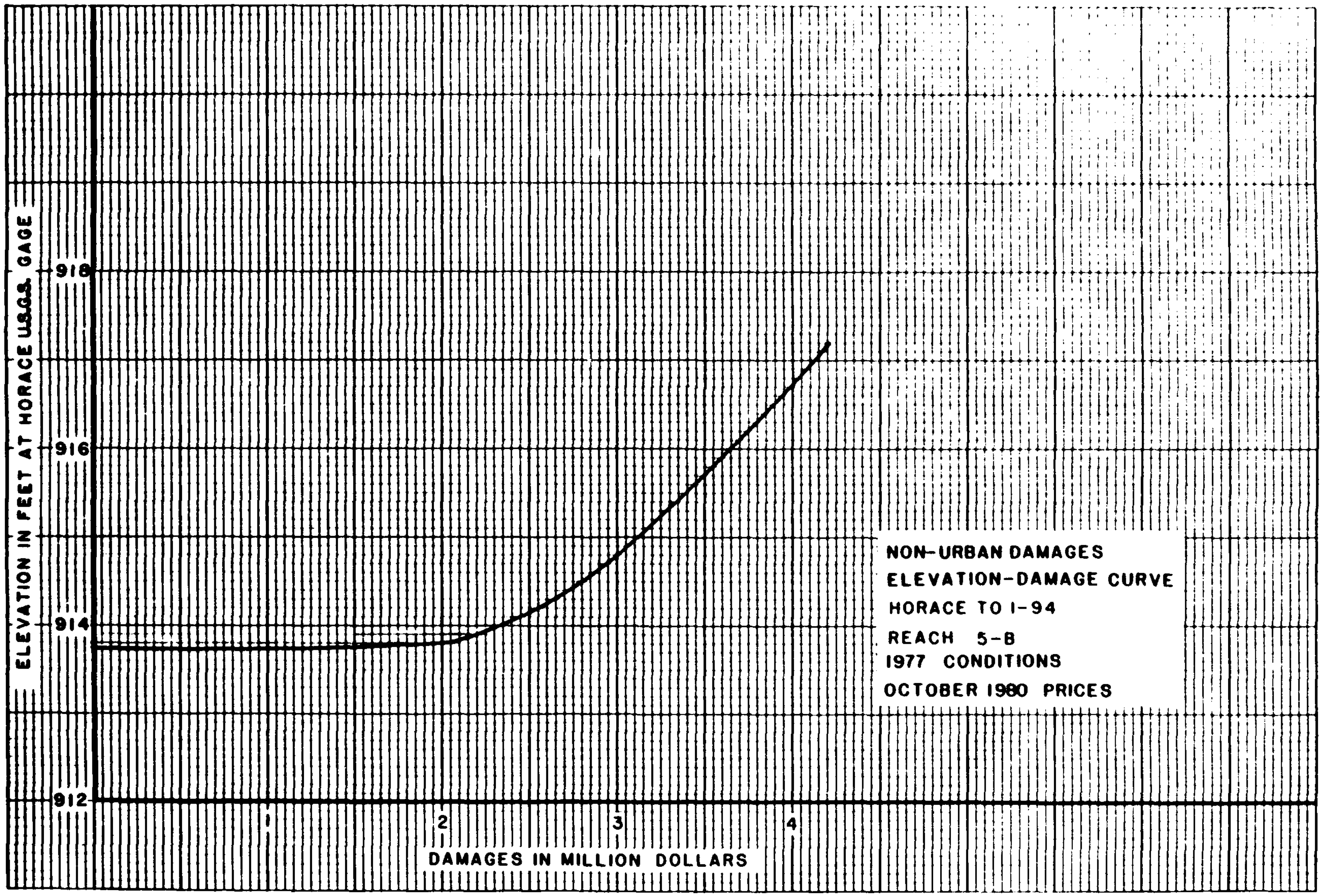
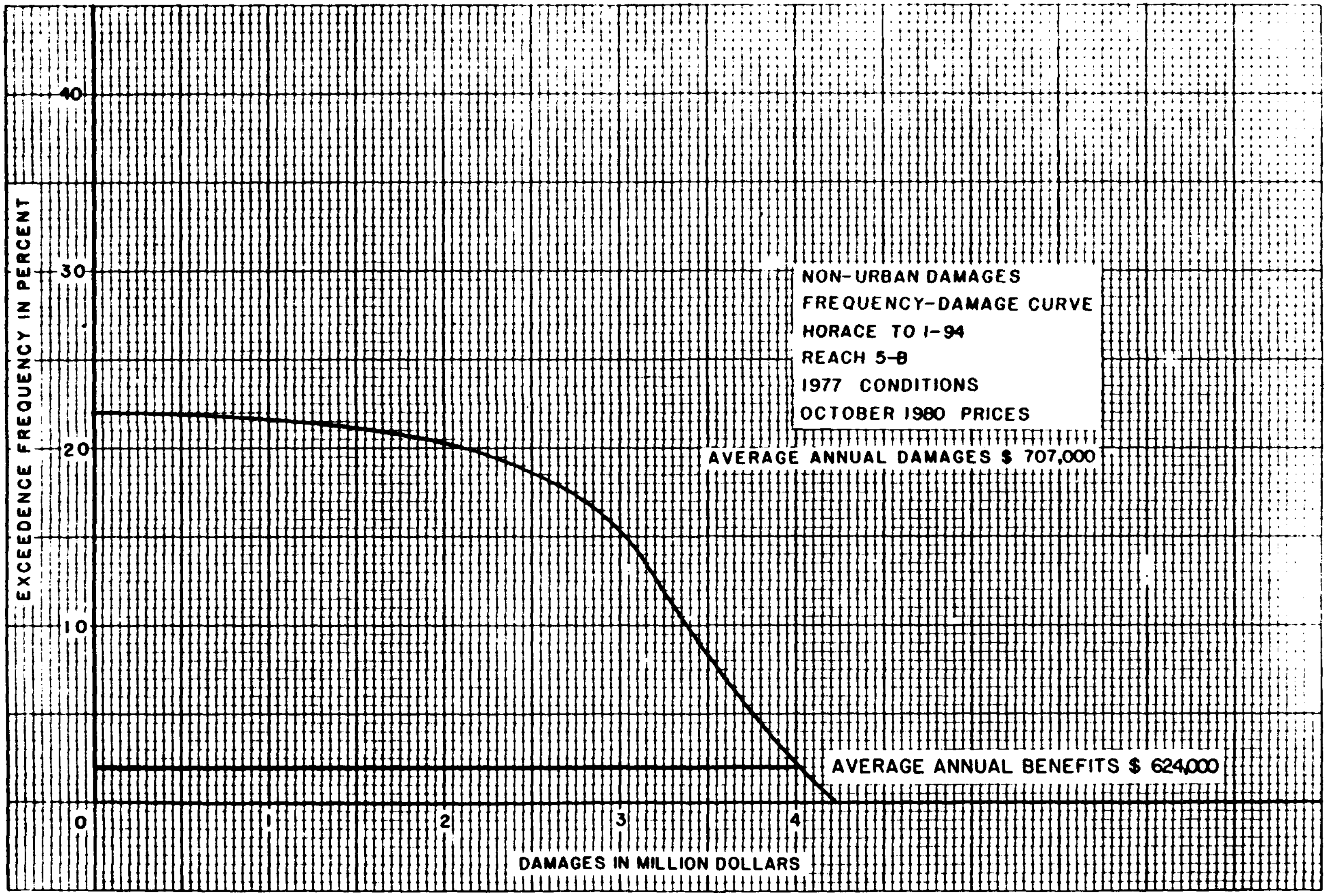

NON-URBAN DAMAGES
ELEVATION-DAMAGE CURVE
HORACE TO I-94
REACH 5-B
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT HORACE U.S.G.S. GAGE
918
916
914
912
1
2
3
4
DAMAGES IN MILLION DOLLARS

PLATE G-18


NON-URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
HORACE TO I-94
REACH 5-B
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $ 707,000
AVERAGE ANNUAL BENEFITS $ 624,000
EXCEEDENCE FREQUENCY IN PERCENT
DAMAGES IN MILLION DOLLARS
0
10
20
30
40
1
2
3
4

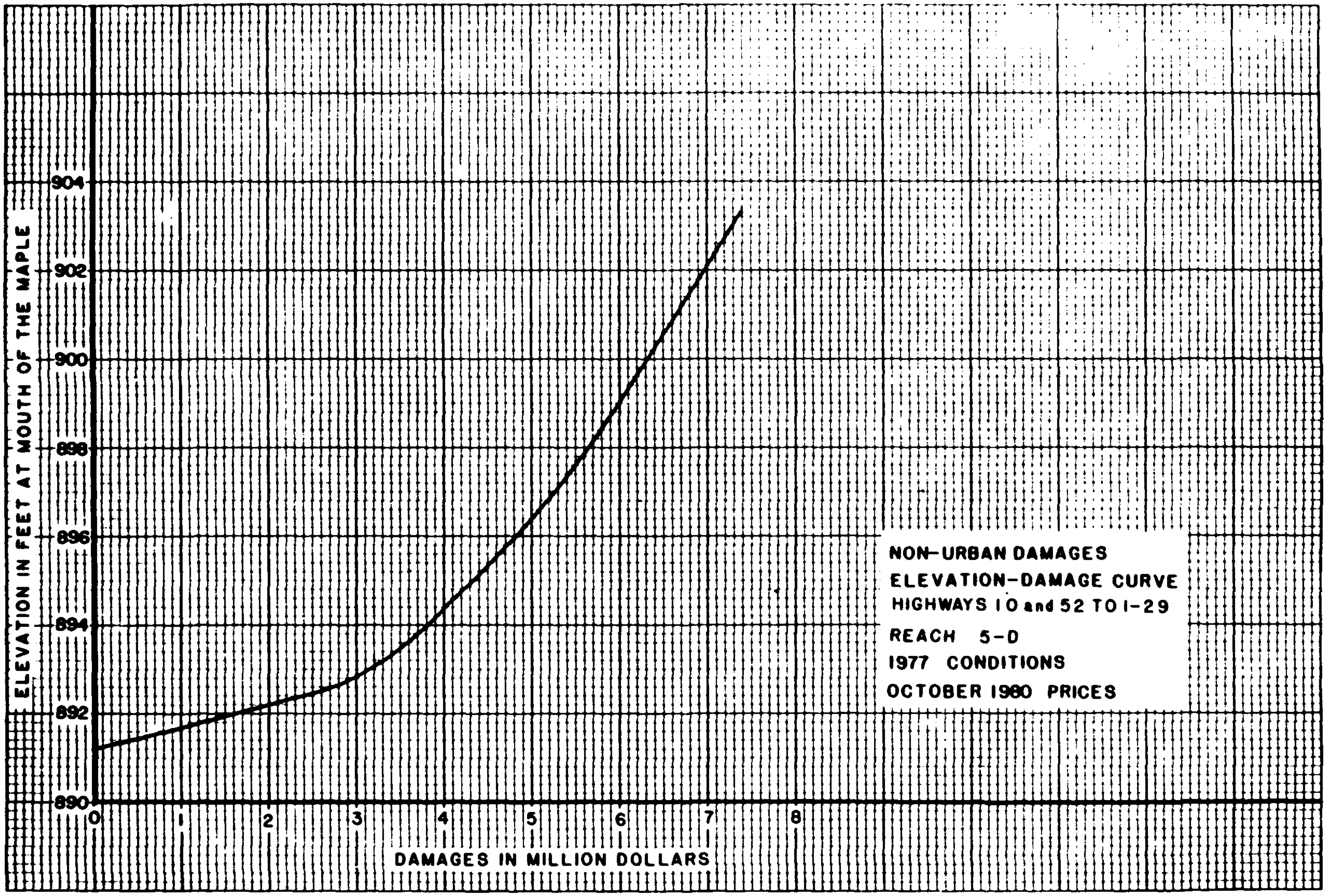

NON-URBAN DAMAGES
ELEVATION-DAMAGE CURVE
HIGHWAYS 10 and 52 TO I-29
REACH 5-D
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT MOUTH OF THE MAPLE
DAMAGES IN MILLION DOLLARS
890
892
894
896
898
900
902
904
0
1
2
3
4
5
6
7
8

PLATE G-20

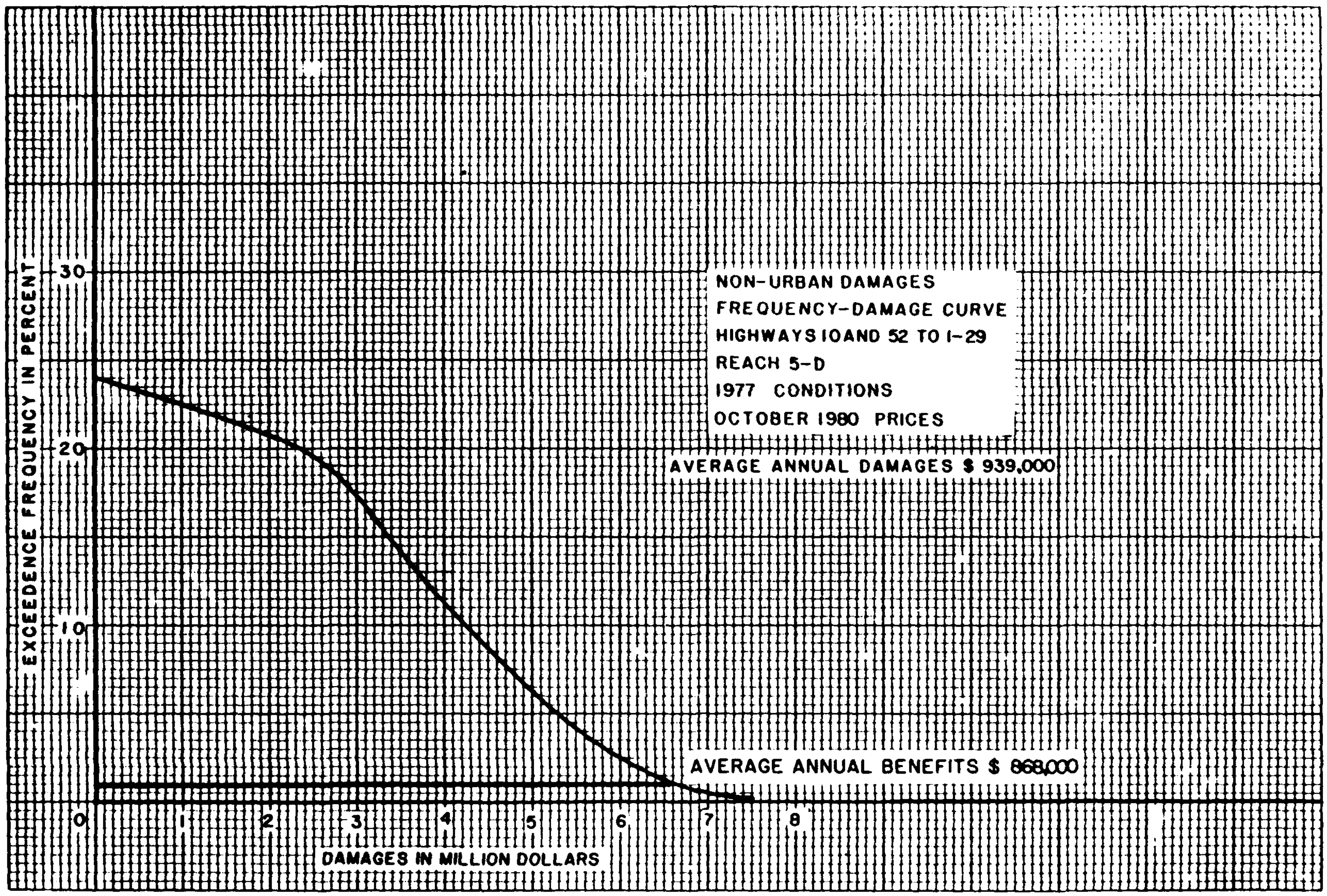

NON-URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
HIGHWAYS 10 AND 52 TO I-29
REACH 5-D
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $ 939,000
AVERAGE ANNUAL BENEFITS $ 868,000
EXCEEDENCE FREQUENCY IN PERCENT
30
20
10
0
1
2
3
4
5
6
7
8
DAMAGES IN MILLION DOLLARS

PLATE G-21

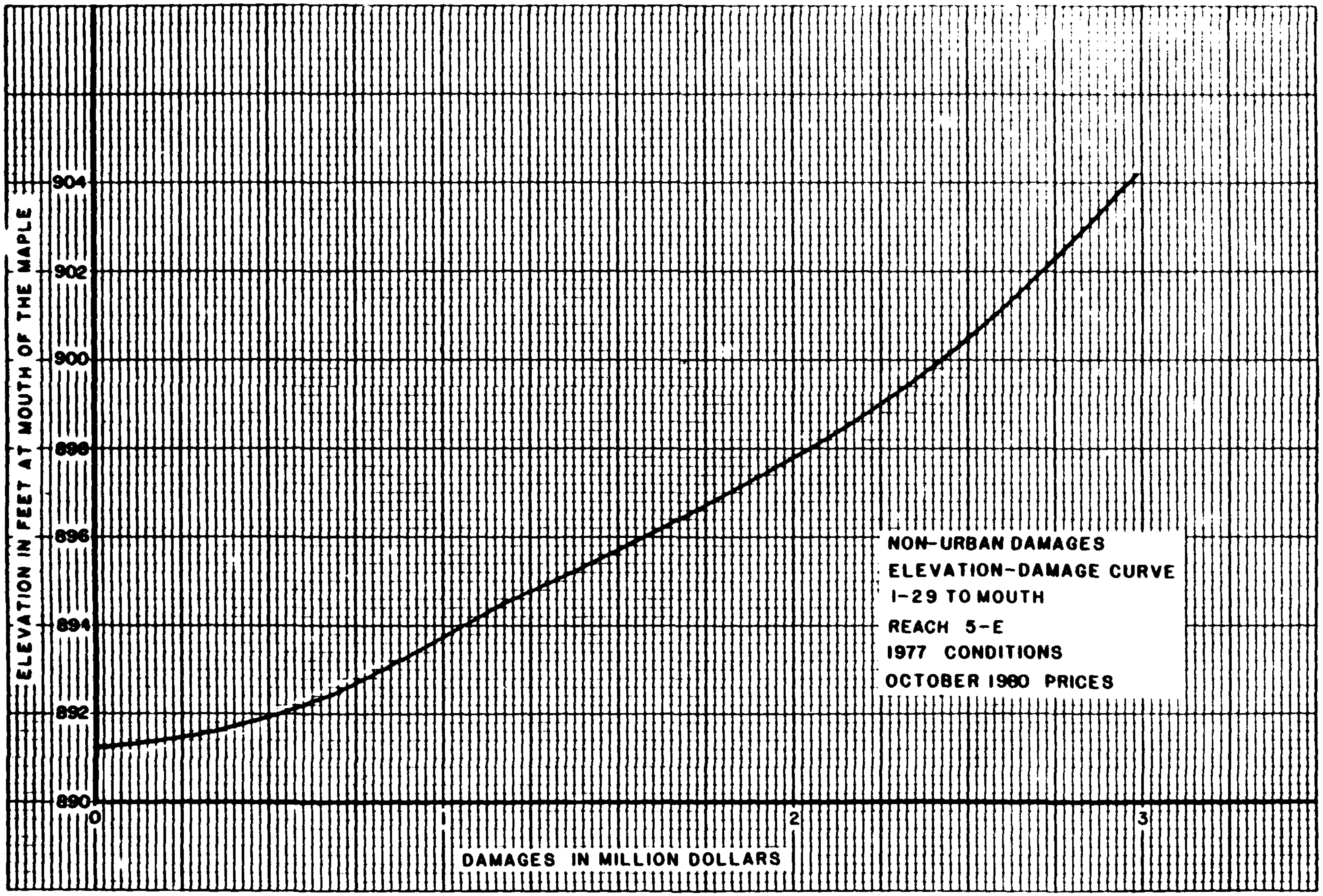
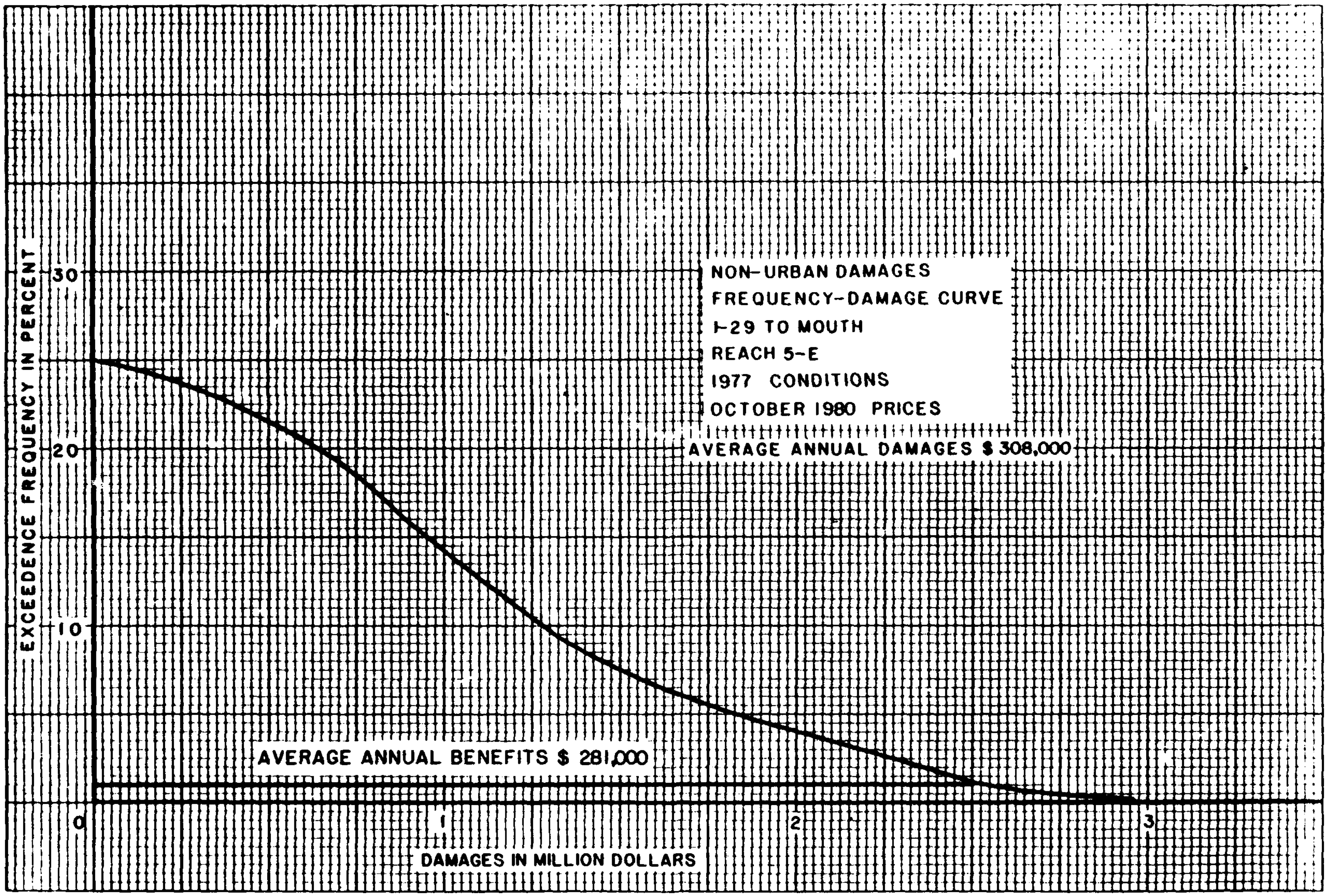

NON-URBAN DAMAGES
ELEVATION-DAMAGE CURVE
I-29 TO MOUTH
REACH 5-E
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT MOUTH OF THE MAPLE
904
902
900
898
896
894
892
890
0
1
2
3
DAMAGES IN MILLION DOLLARS

PLATE G-22



NON-URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
I-29 TO MOUTH
REACH 5-E
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $ 308,000
AVERAGE ANNUAL BENEFITS $ 281,000
EXCEEDENCE FREQUENCY IN PERCENT
30
20
10
0
1
2
3
DAMAGES IN MILLION DOLLARS

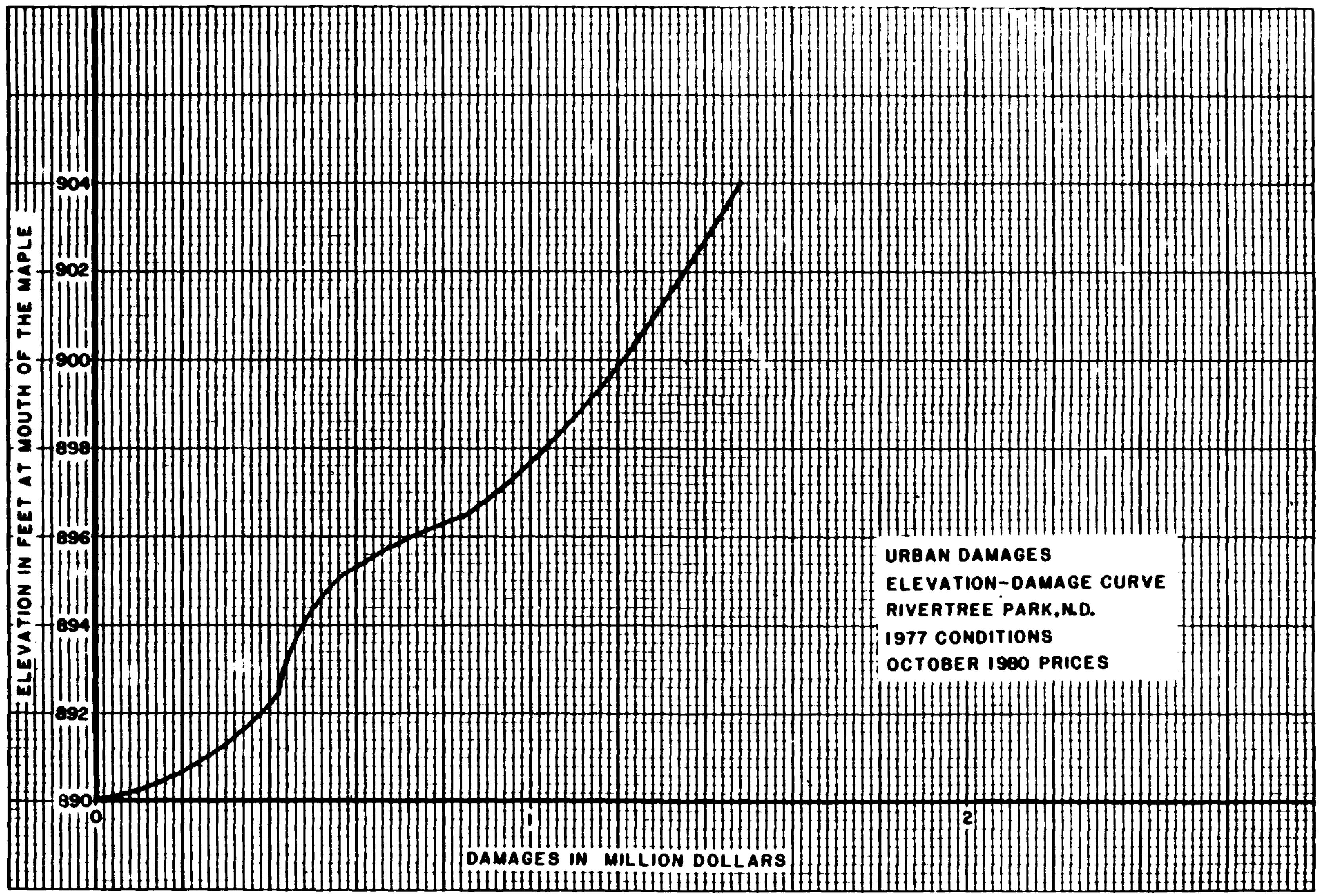

URBAN DAMAGES
ELEVATION-DAMAGE CURVE
RIVERTREE PARK, N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT MOUTH OF THE MAPLE
904
902
900
898
896
894
892
890
0
1
2
DAMAGES IN MILLION DOLLARS

PLATE G-24

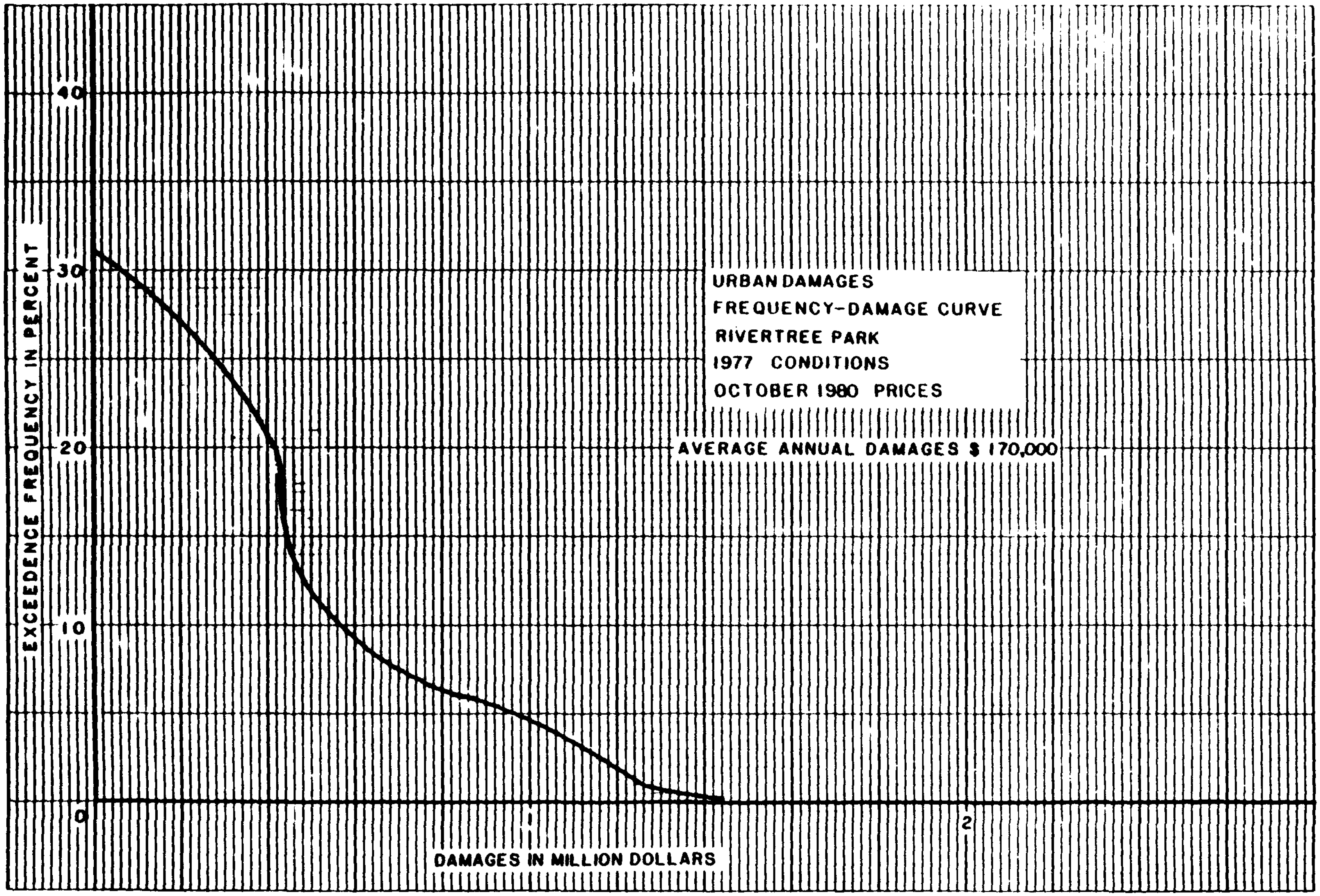

URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
RIVERTREE PARK
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $ 170,000
EXCEEDENCE FREQUENCY IN PERCENT
40
30
20
10
0
2
DAMAGES IN MILLION DOLLARS

PLATE G-25

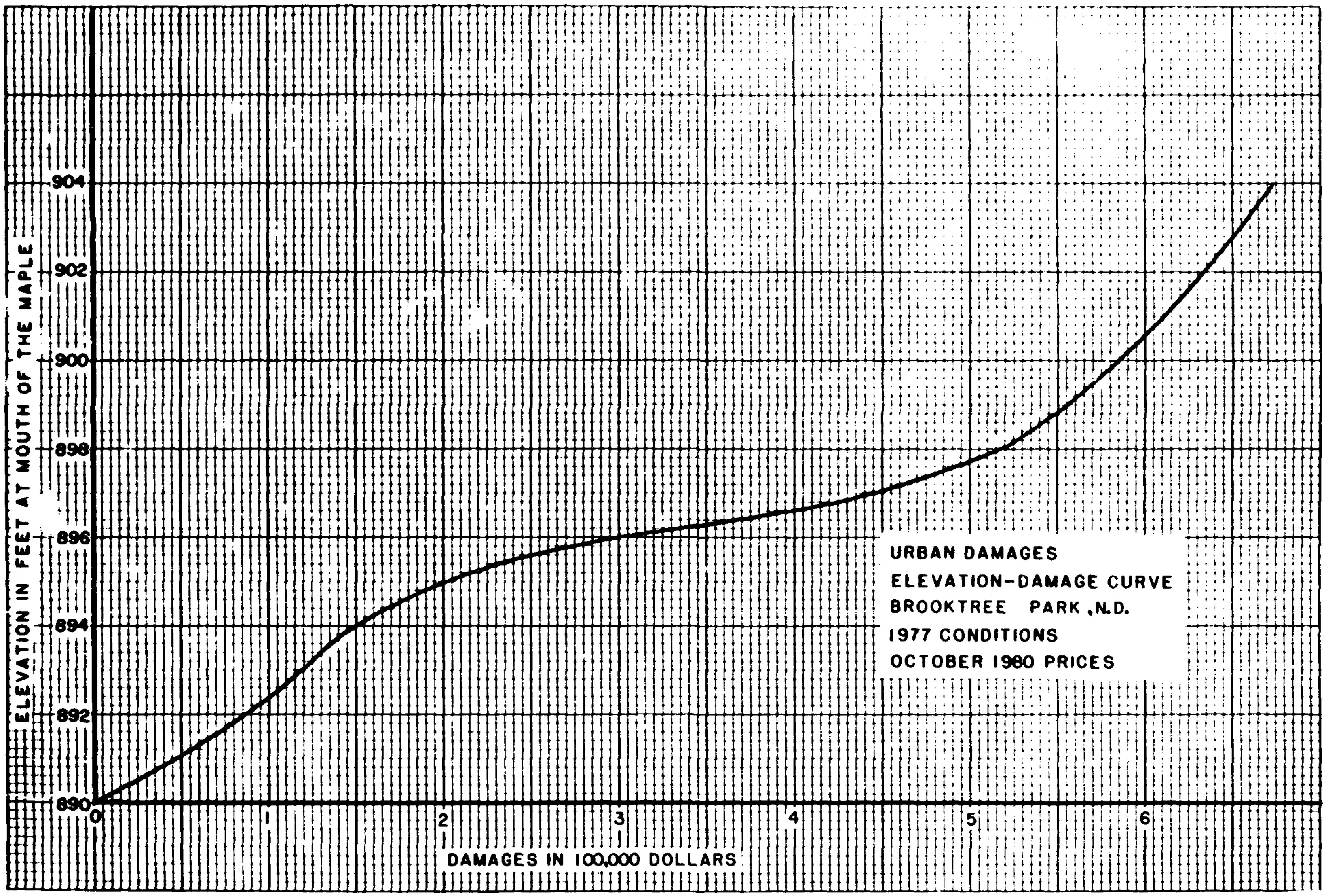

URBAN DAMAGES
ELEVATION-DAMAGE CURVE
BROOKTREE PARK, N.D.
1977 CONDITIONS
OCTOBER 1980 PRICES
ELEVATION IN FEET AT MOUTH OF THE MAPLE
904
902
900
898
896
894
892
890
0
1
2
3
4
5
6
DAMAGES IN 100,000 DOLLARS

PLATE G-26

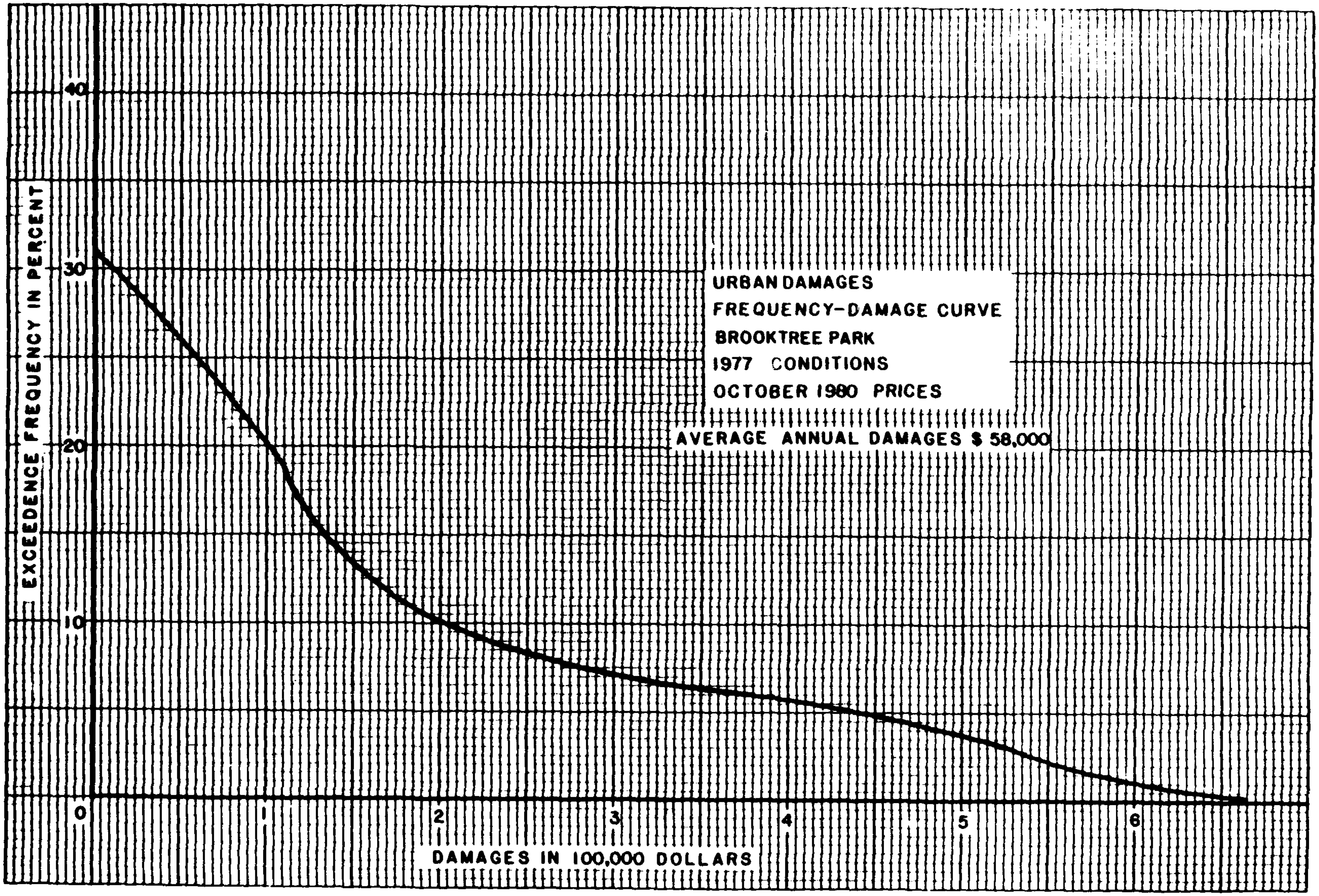

URBAN DAMAGES
FREQUENCY-DAMAGE CURVE
BROOKTREE PARK
1977 CONDITIONS
OCTOBER 1980 PRICES
AVERAGE ANNUAL DAMAGES $ 58,000
EXCEEDENCE FREQUENCY IN PERCENT
40
30
20
10
0
1
2
3
4
5
6
DAMAGES IN 100,000 DOLLARS

PLATE G-27

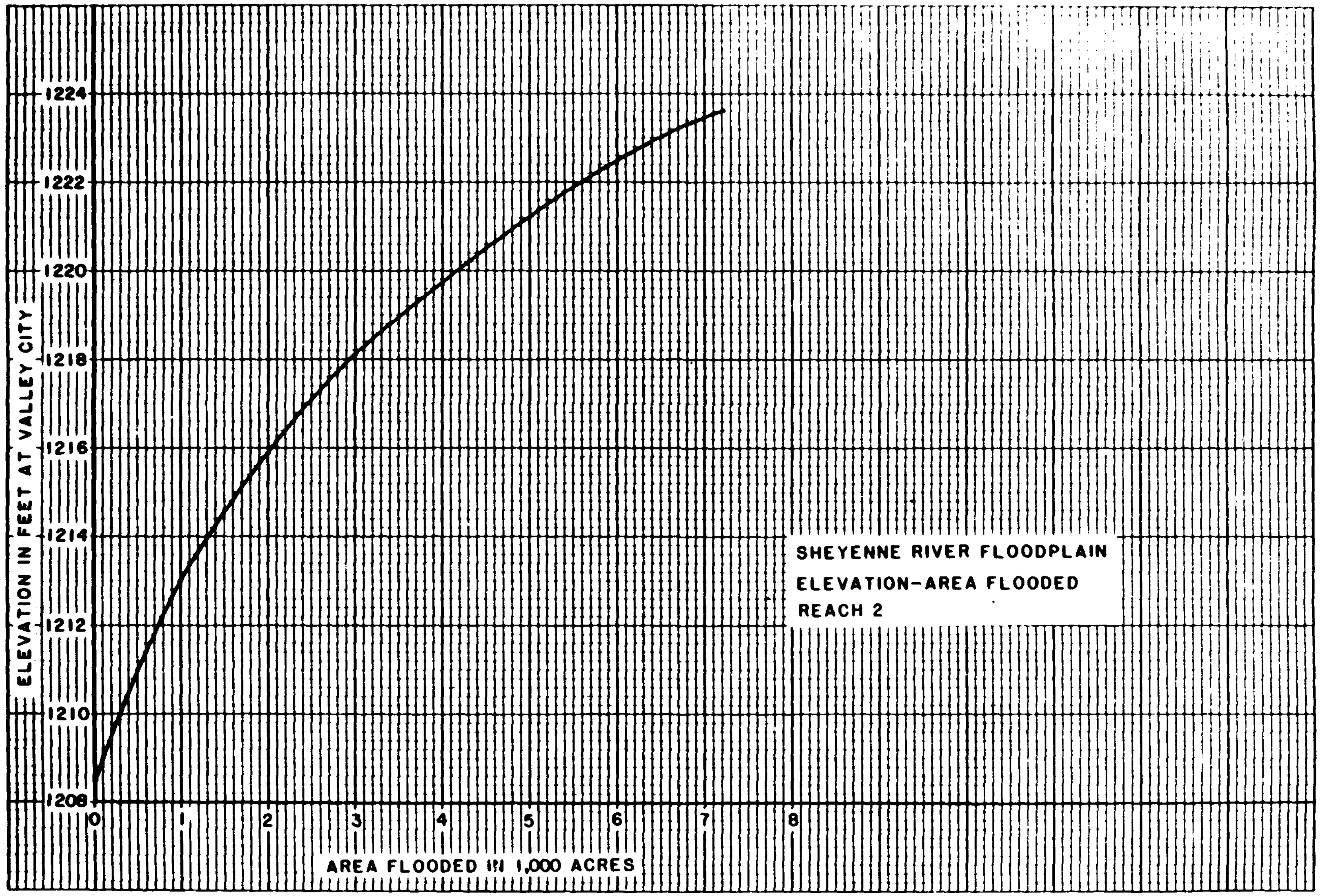
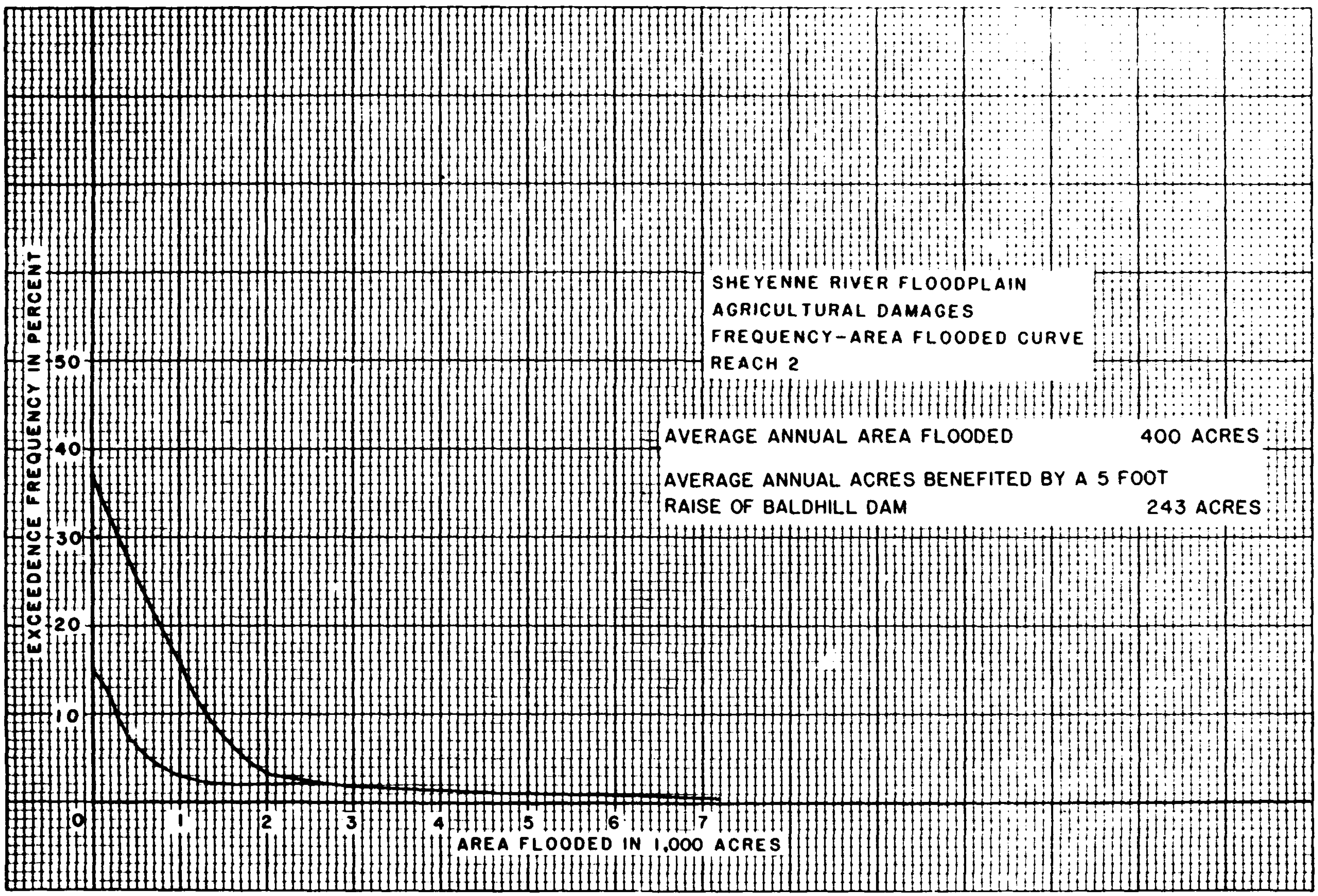

SHEYENNE RIVER FLOODPLAIN
ELEVATION-AREA FLOODED
REACH 2
ELEVATION IN FEET AT VALLEY CITY
1224
1222
1220
1218
1216
1214
1212
1210
1208
0
1
2
3
4
5
6
7
8
AREA FLOODED IN 1,000 ACRES

PLATE G-28



SHEYENNE RIVER FLOODPLAIN
AGRICULTURAL DAMAGES
FREQUENCY-AREA FLOODED CURVE
REACH 2
AVERAGE ANNUAL AREA FLOODED 400 ACRES
AVERAGE ANNUAL ACRES BENEFITED BY A 5 FOOT
RAISE OF BALDHILL DAM 243 ACRES
EXCEEDENCE FREQUENCY IN PERCENT
50
40
30
20
10
0
1
2
3
4
5
6
7
AREA FLOODED IN 1,000 ACRES

PLATE G-29

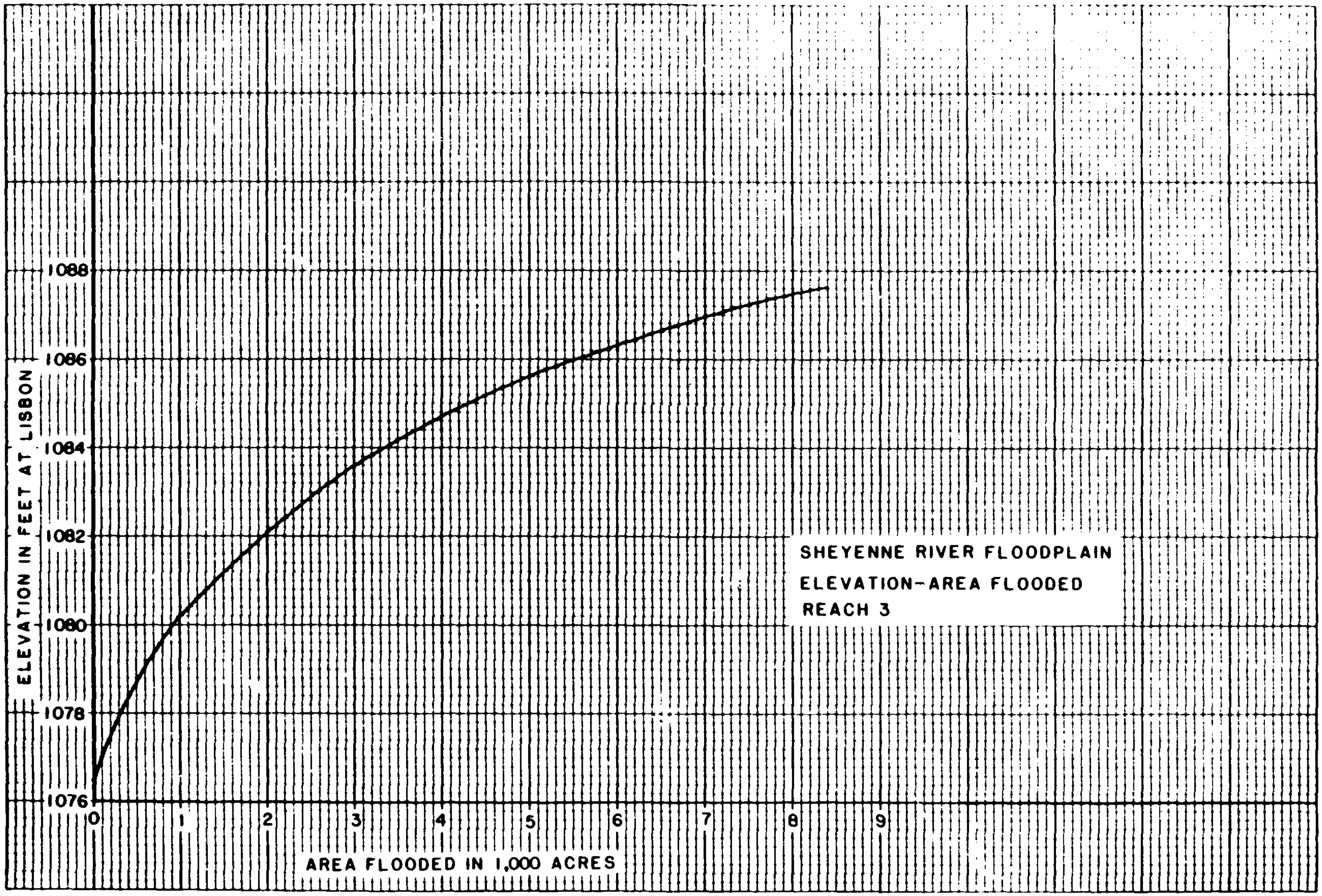
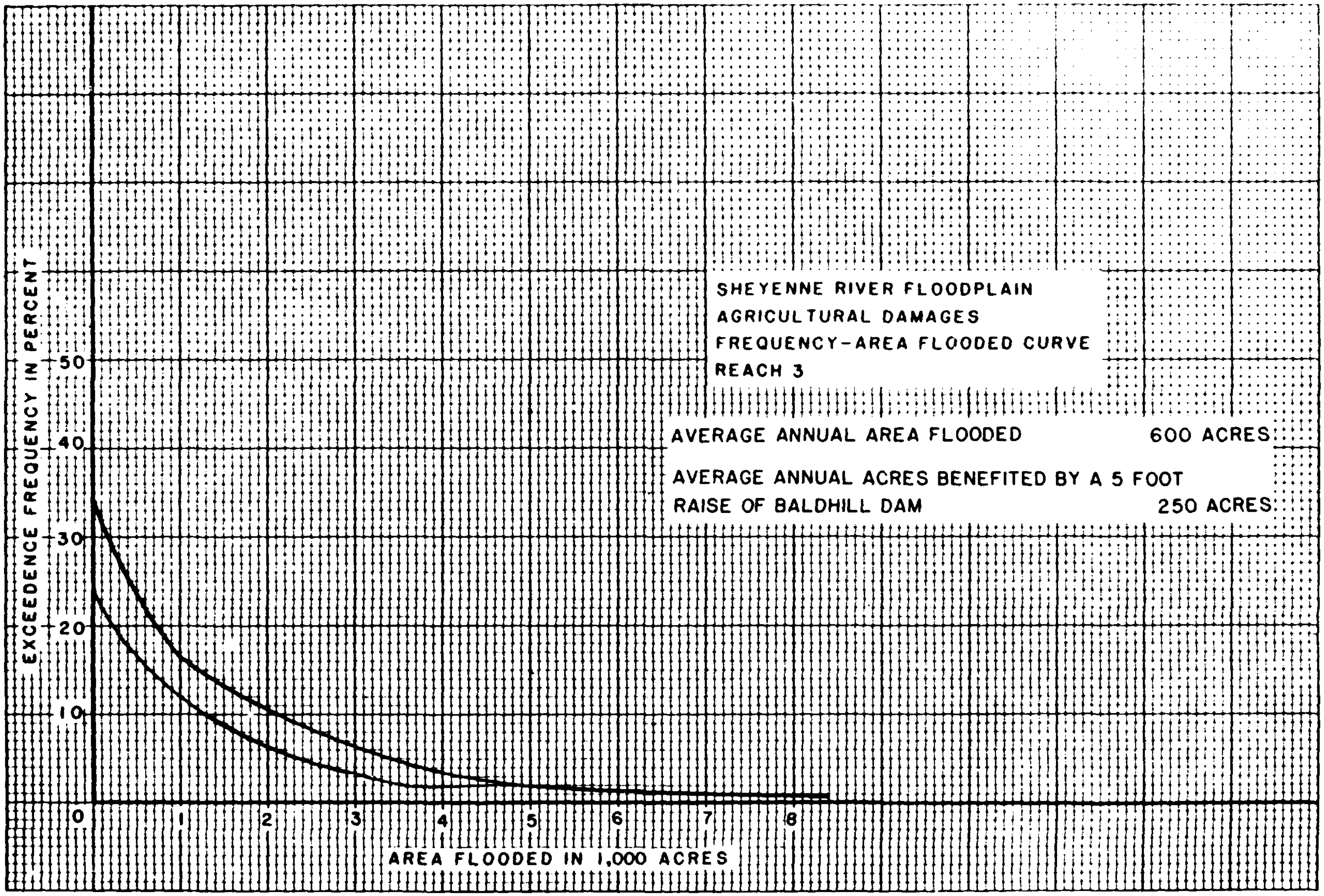

SHEYENNE RIVER FLOODPLAIN
ELEVATION-AREA FLOODED
REACH 3
ELEVATION IN FEET AT LISBON
1076
1078
1080
1082
1084
1086
1088
0
1
2
3
4
5
6
7
8
9
AREA FLOODED IN 1,000 ACRES

PLATE G-30


SHEYENNE RIVER FLOODPLAIN
AGRICULTURAL DAMAGES
FREQUENCY-AREA FLOODED CURVE
REACH 3
AVERAGE ANNUAL AREA FLOODED 600 ACRES
AVERAGE ANNUAL ACRES BENEFITED BY A 5 FOOT
RAISE OF BALDHILL DAM 250 ACRES
EXCEEDENCE FREQUENCY IN PERCENT
50
40
30
20
10
0
1
2
3
4
5
6
7
8
AREA FLOODED IN 1,000 ACRES

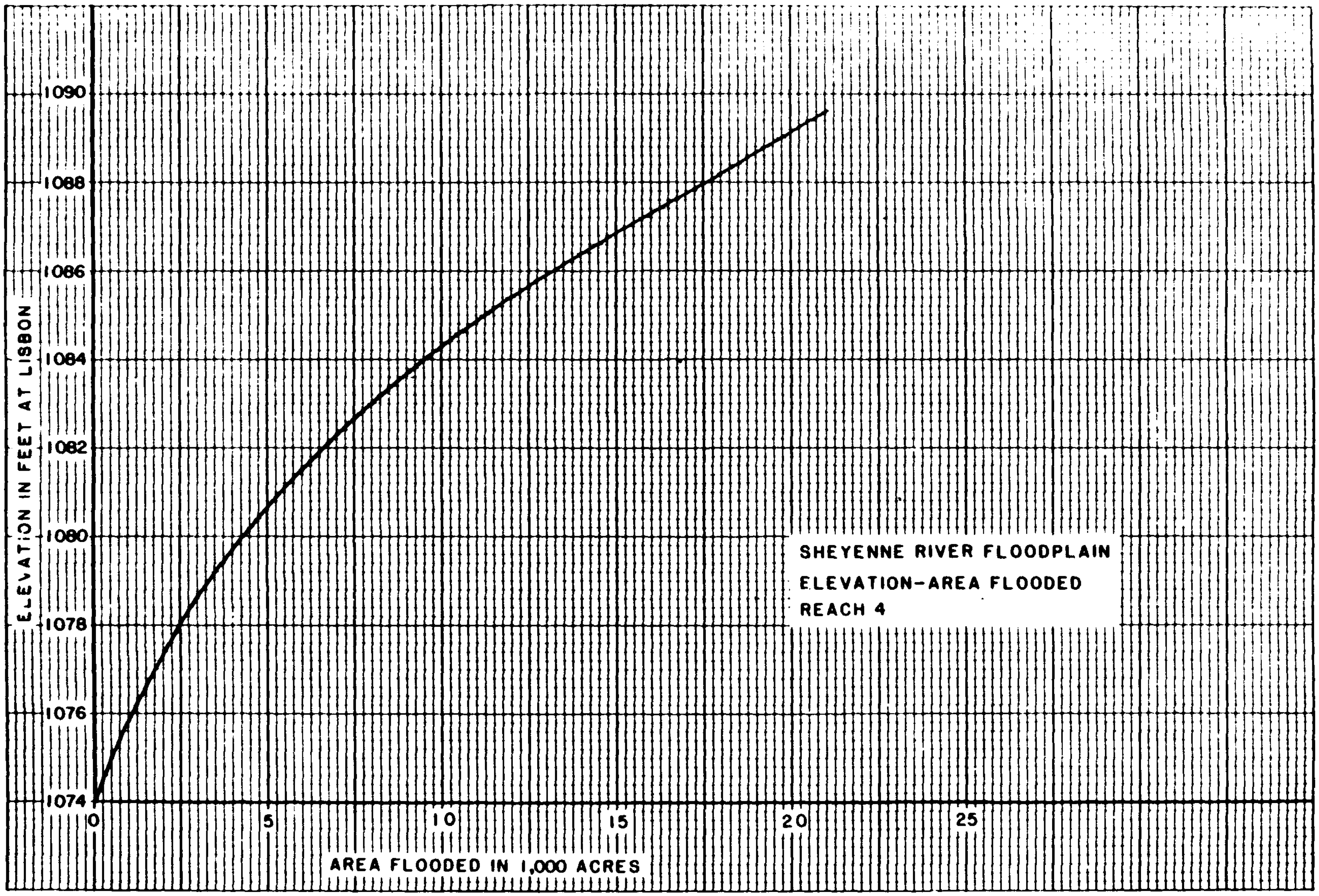
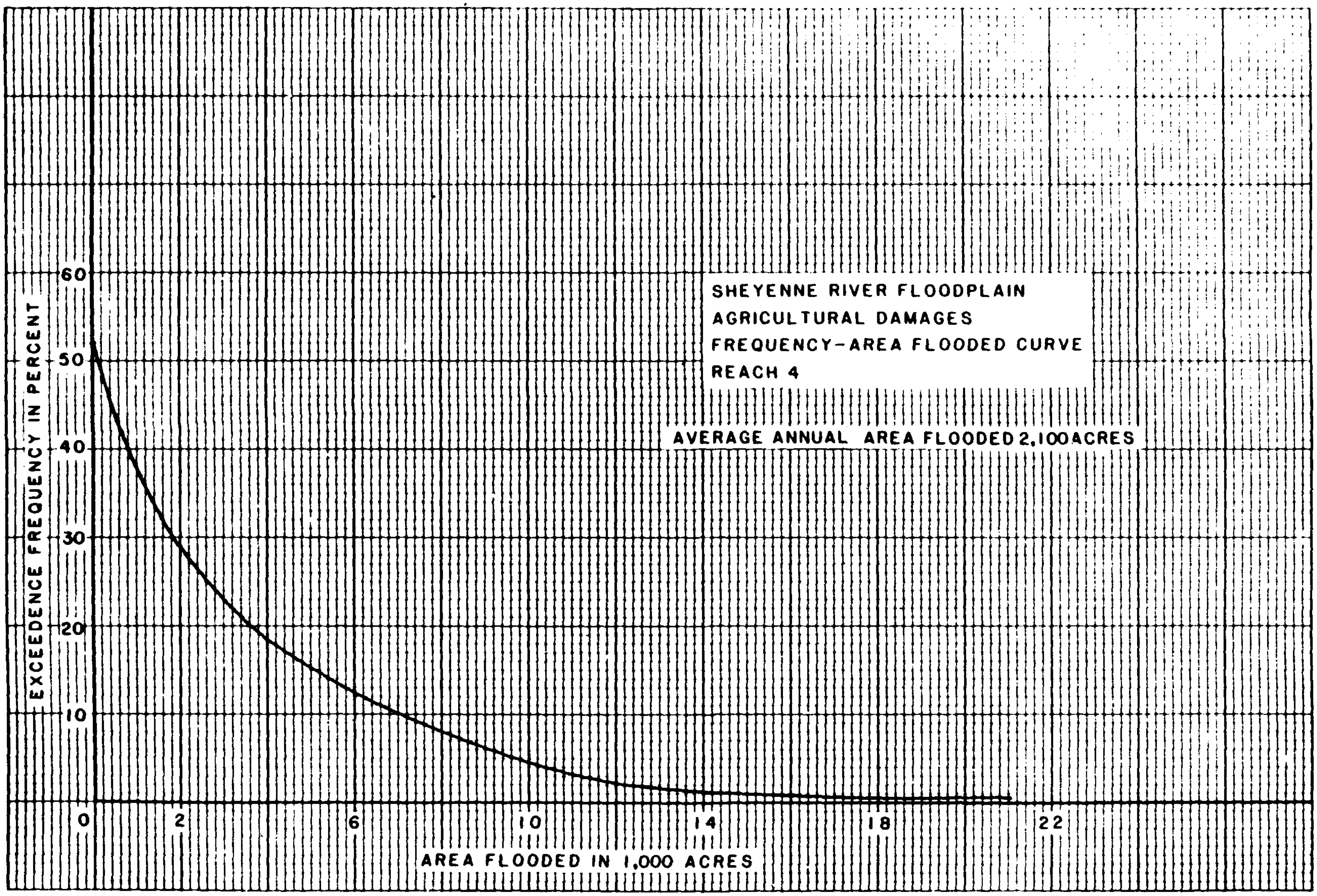
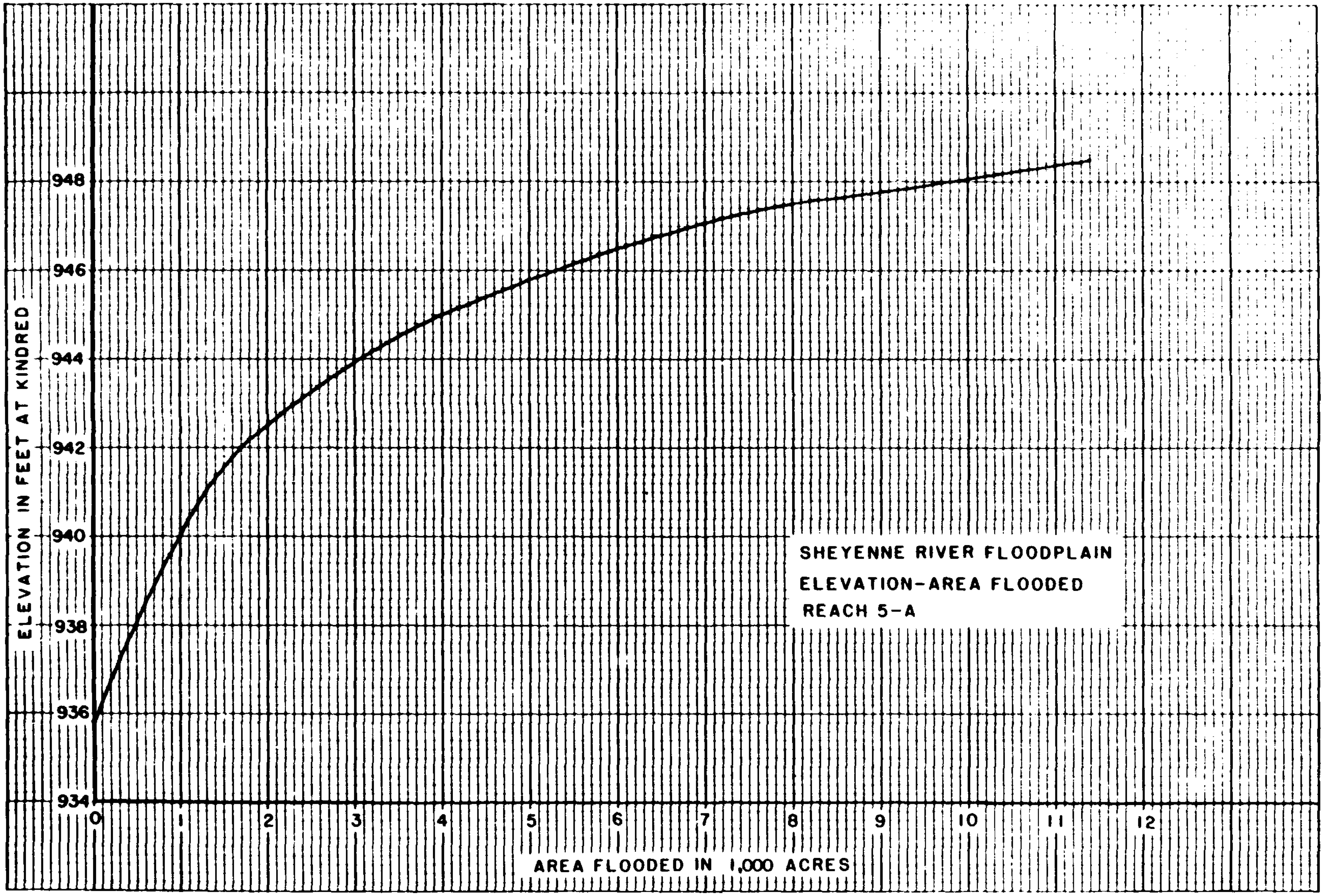
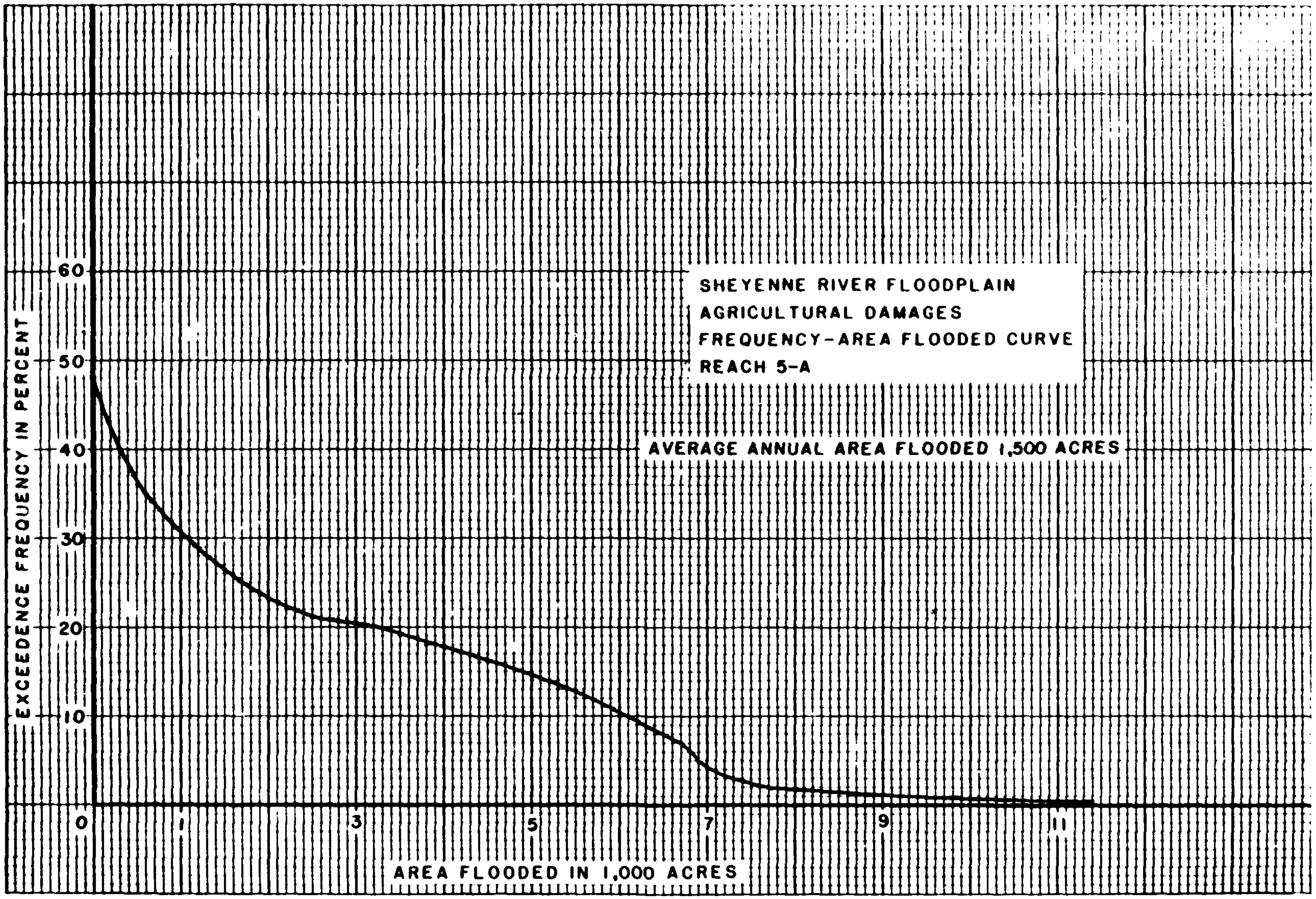

SHEYENNE RIVER FLOODPLAIN
ELEVATION-AREA FLOODED
REACH 4
ELEVATION IN FEET AT LISBON
1090
1088
1086
1084
1082
1080
1078
1076
1074
0
5
10
15
20
25
AREA FLOODED IN 1,000 ACRES

PLATE G-32



SHEYENNE RIVER FLOODPLAIN
AGRICULTURAL DAMAGES
FREQUENCY-AREA FLOODED CURVE
REACH 4
AVERAGE ANNUAL AREA FLOODED 2,100 ACRES
EXCEEDENCE FREQUENCY IN PERCENT
60
50
40
30
20
10
0
2
6
10
14
18
22
AREA FLOODED IN 1,000 ACRES


SHEYENNE RIVER FLOODPLAIN
ELEVATION-AREA FLOODED
REACH 5-A
ELEVATION IN FEET AT KINDRED
948
946
944
942
940
938
936
934
0
1
2
3
4
5
6
7
8
9
10
11
12
AREA FLOODED IN 1,000 ACRES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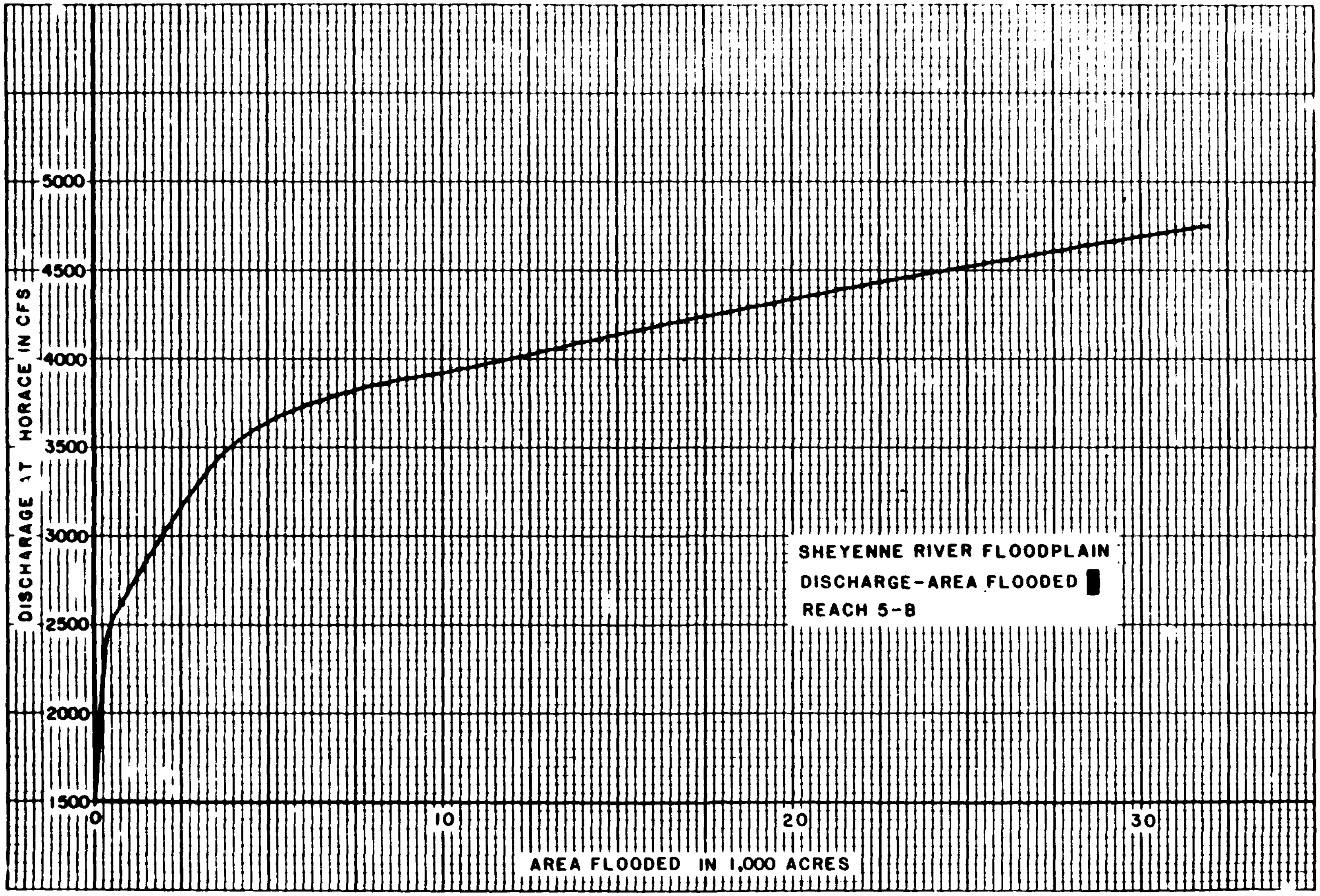
AGRICULTURAL DAMAGES
FREQUENCY-AREA FLOODED CURVE
REACH 5-A
AVERAGE ANNUAL AREA FLOODED 1,500 ACRES
EXCEEDENCE FREQUENCY IN PERCENT
AREA FLOODED IN 1,000 ACRES
0
10
20
30
40
50
60
1
3
5
7
9
11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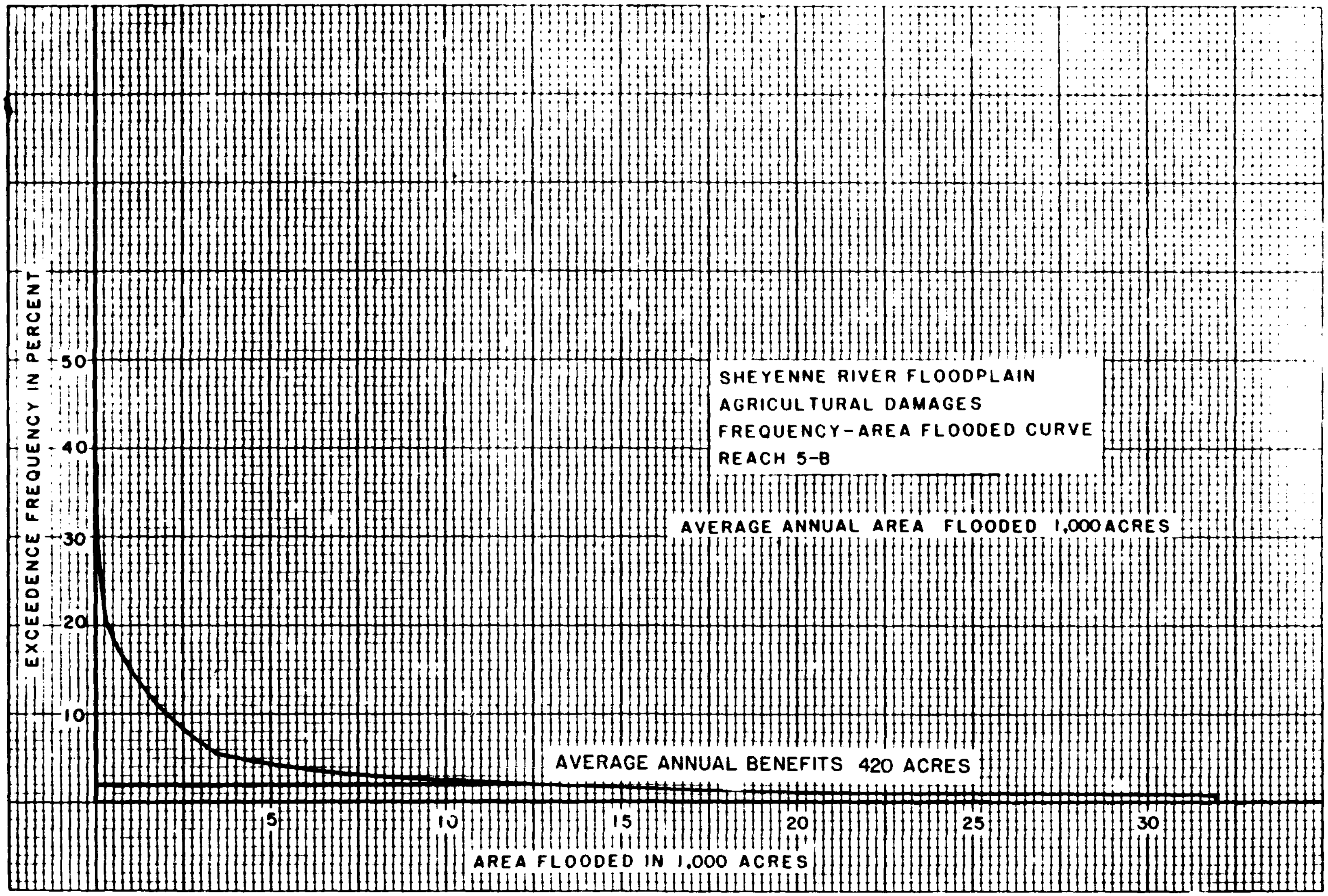
DISCHARGE-AREA FLOODED
REACH 5-B
DISCHARAGE AT HORACE IN CFS
5000
4500
4000
3500
3000
2500
2000
1500
0
10
20
30
AREA FLOODED IN 1,000 ACRES

PLATE G-36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AGRICULTURAL DAMAGES
FREQUENCY-AREA FLOODED CURVE
REACH 5-B
AVERAGE ANNUAL AREA FLOODED 1,000 ACRES
AVERAGE ANNUAL BENEFITS 420 ACRES
EXCEEDENCE FREQUENCY IN PERCENT
10
20
30
40
50
5
10
15
20
25
30
AREA FLOODED IN 1,000 ACRES

PLATE G-37

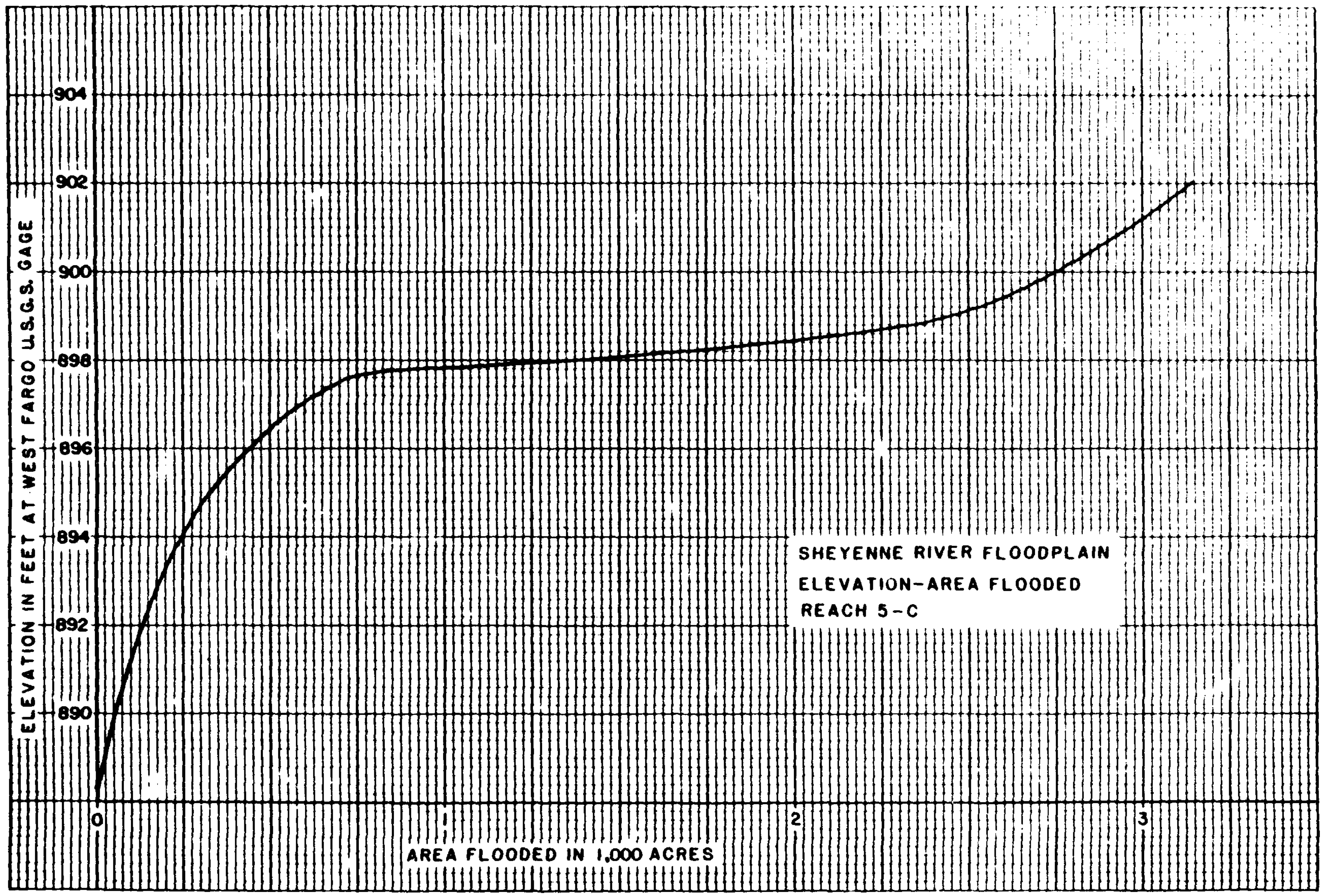
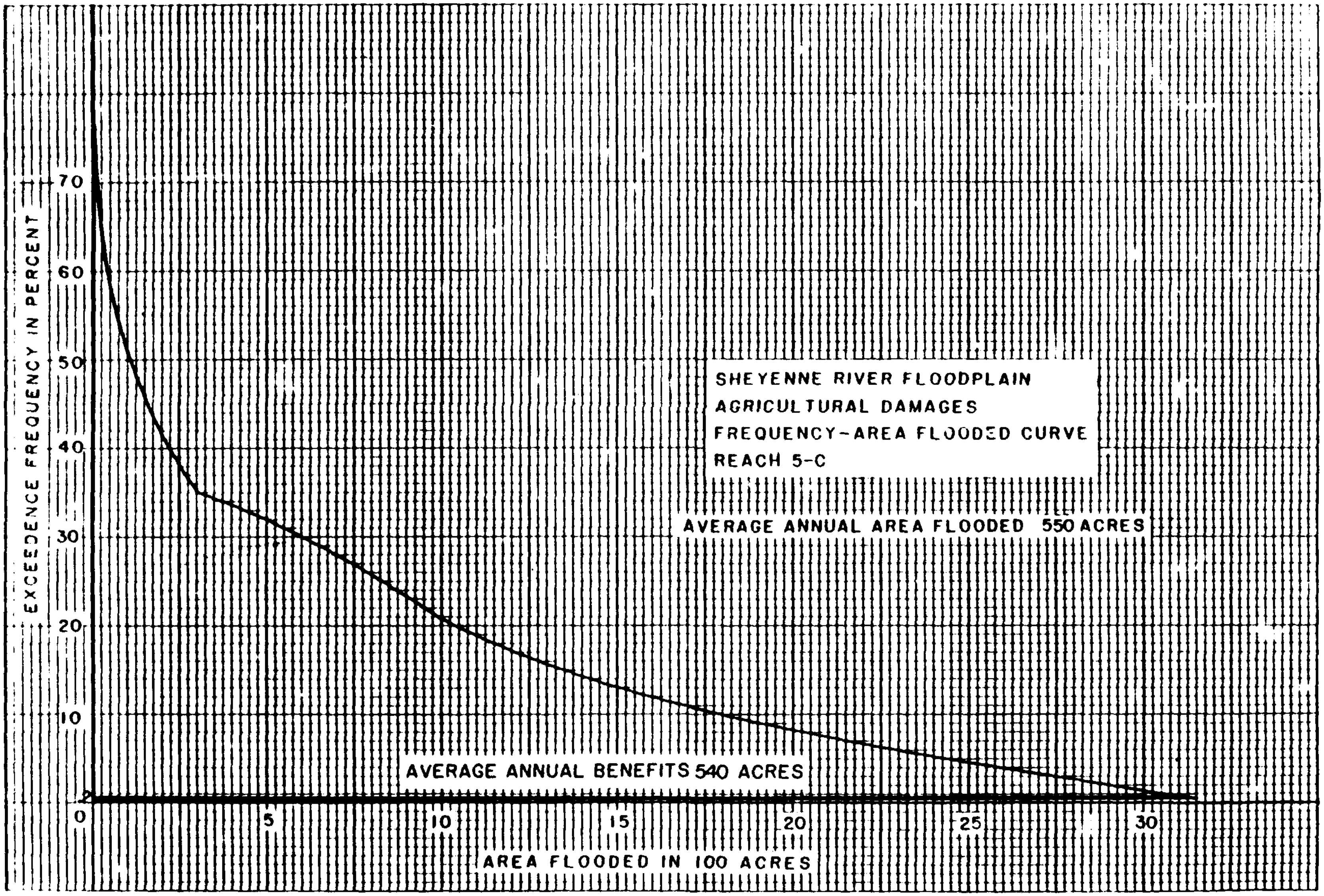

SHEYENNE RIVER FLOODPLAIN
ELEVATION-AREA FLOODED
REACH 5-C
ELEVATION IN FEET AT WEST FARGO U.S.G.S. GAGE
904
902
900
898
896
894
892
890
0
1
2
3
AREA FLOODED IN 1,000 ACRES

PLATE G-38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AGRICULTURAL DAMAGES
FREQUENCY-AREA FLOODED CURVE
REACH 5-C
AVERAGE ANNUAL AREA FLOODED 550 ACRES
AVERAGE ANNUAL BENEFITS 540 ACRES
EXCEEDENCE FREQUENCY IN PERCENT
70
60
50
40
30
20
10
2
0
5
10
15
20
25
30
AREA FLOODED IN 100 ACRES

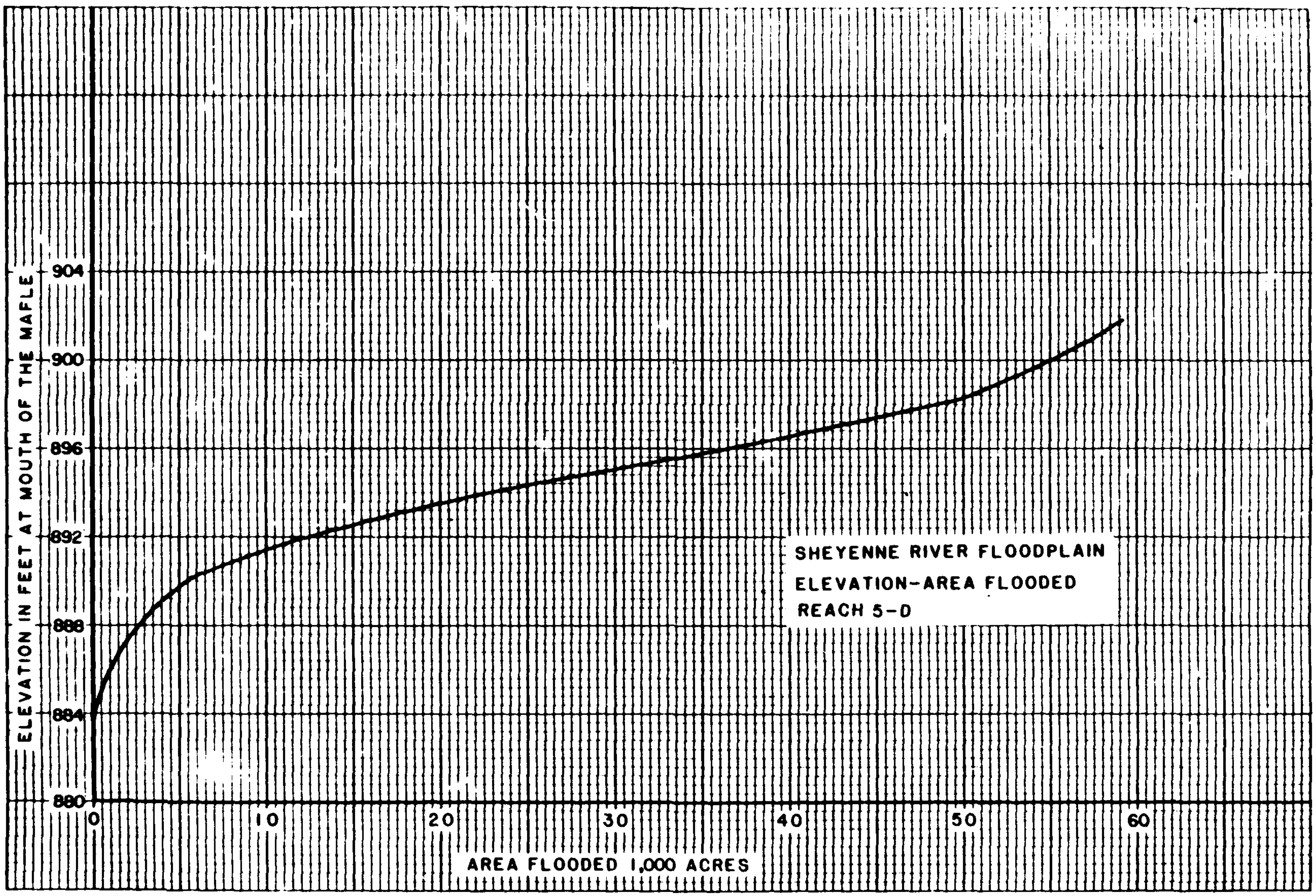
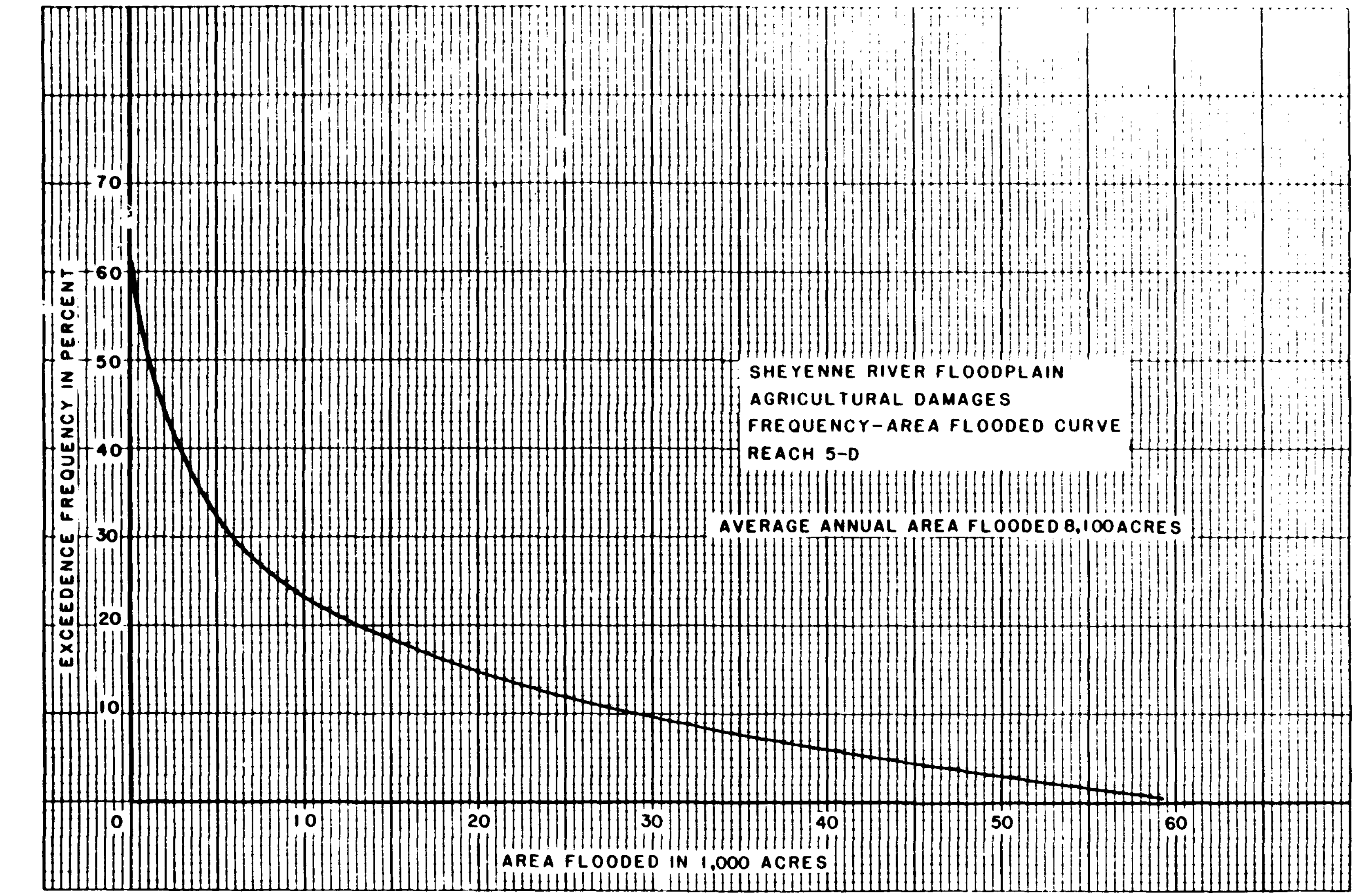
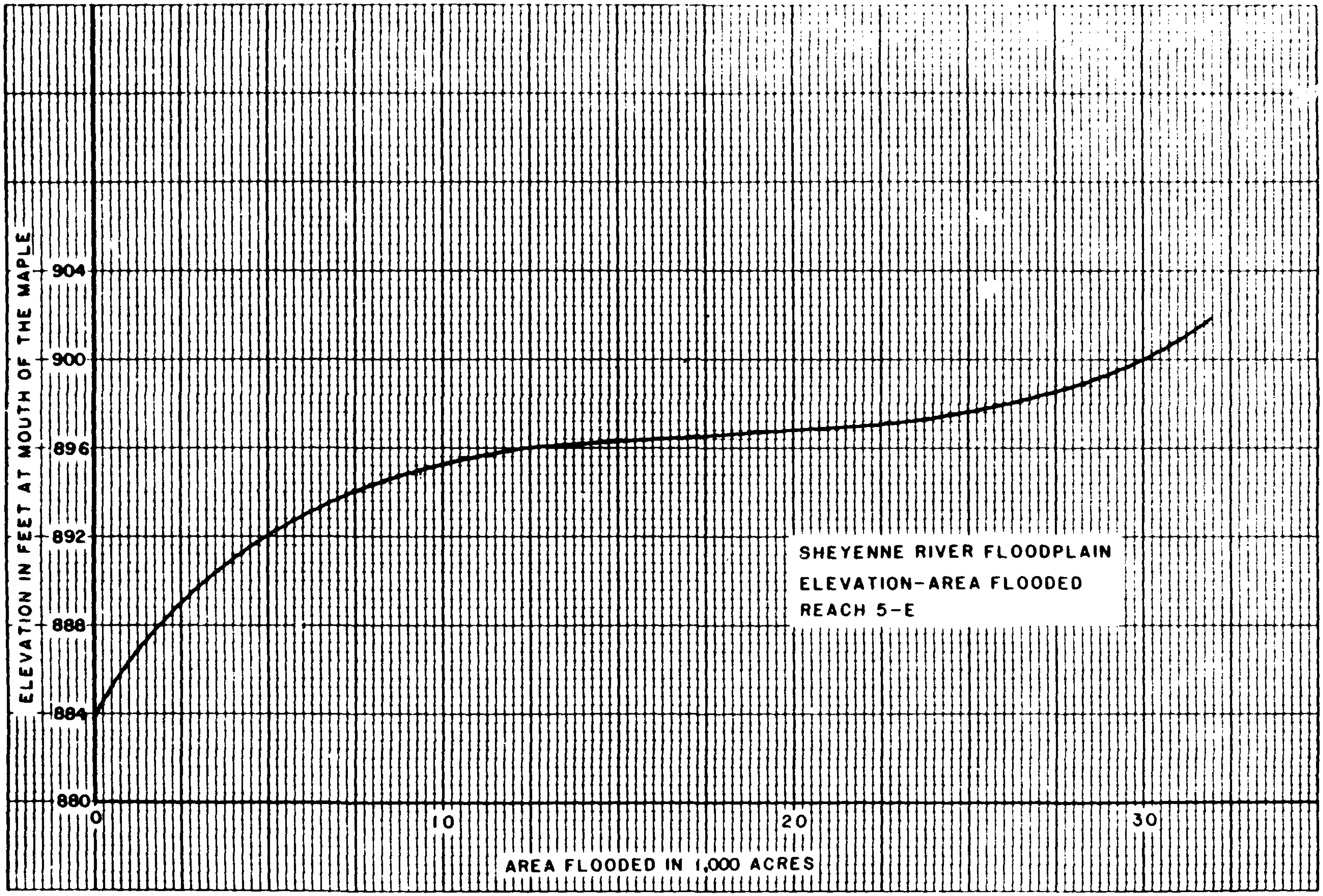
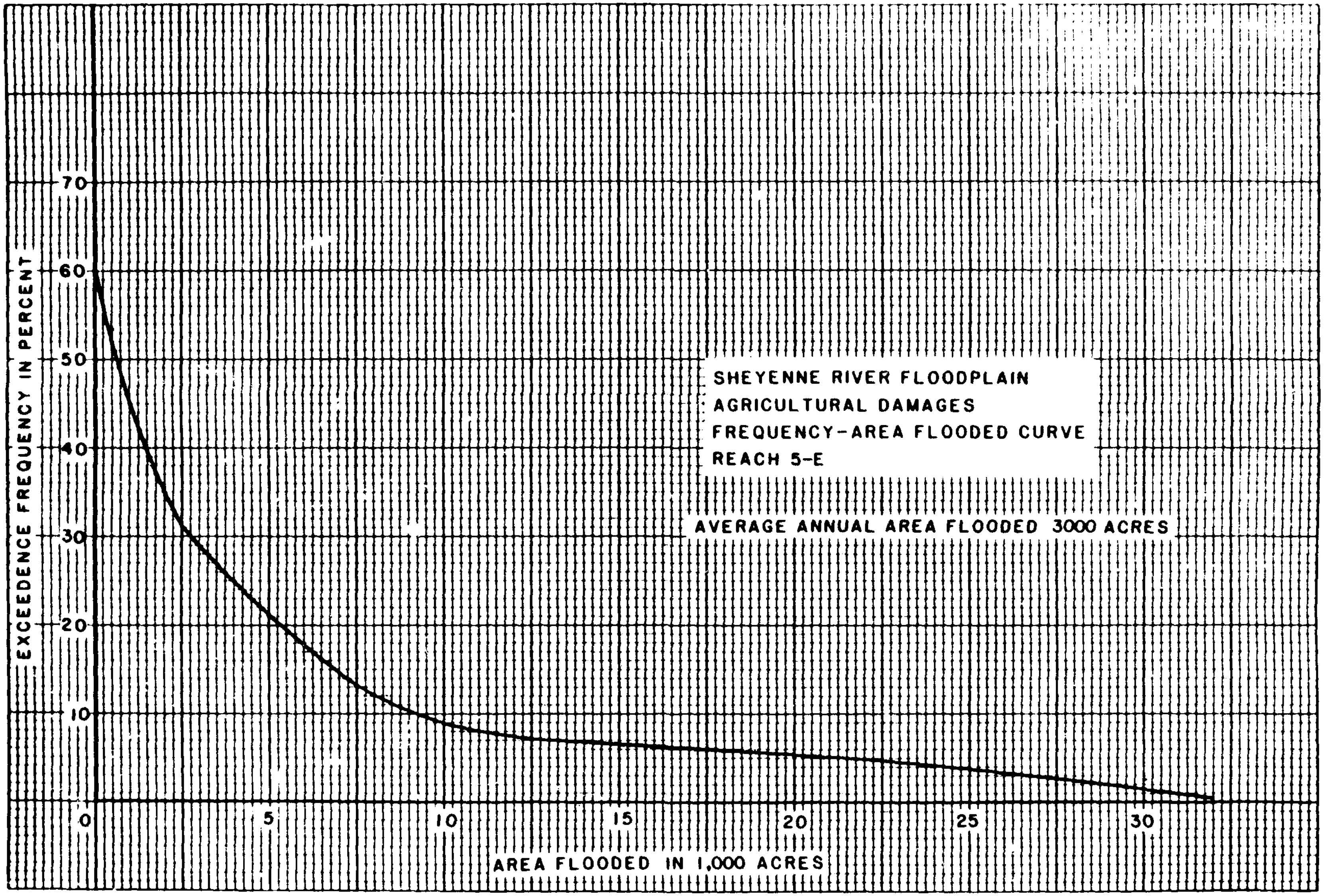

SHEYENNE RIVER FLOODPLAIN
ELEVATION-AREA FLOODED
REACH 5-D
ELEVATION IN FEET AT MOUTH OF THE MAPLE
880
884
888
892
896
900
904
AREA FLOODED 1,000 ACRES
0
10
20
30
40
50
60

PLATE G-40



SHEYENNE RIVER FLOODPLAIN
AGRICULTURAL DAMAGES
FREQUENCY-AREA FLOODED CURVE
REACH 5-D
AVERAGE ANNUAL AREA FLOODED 8,100 ACRES
EXCEEDENCE FREQUENCY IN PERCENT
AREA FLOODED IN 1,000 ACRES
0
10
20
30
40
50
60
70


SHEYENNE RIVER FLOODPLAIN
ELEVATION-AREA FLOODED
REACH 5-E
ELEVATION IN FEET AT MOUTH OF THE MAPLE
904
900
896
892
888
884
880
0
10
20
30
AREA FLOODED IN 1,000 ACRES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AGRICULTURAL DAMAGES
FREQUENCY-AREA FLOODED CURVE
REACH 5-E
AVERAGE ANNUAL AREA FLOODED 3000 ACRES
EXCEEDENCE FREQUENCY IN PERCENT
70
60
50
40
30
20
10
0
5
10
15
20
25
30
AREA FLOODED IN 1,000 ACRES

AD-A147 702 GENERAL REEVALUATION AND ENVIRONMENTAL IMPACT STATEMENT FOR FLOOD CONTROL..(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT JAN 84

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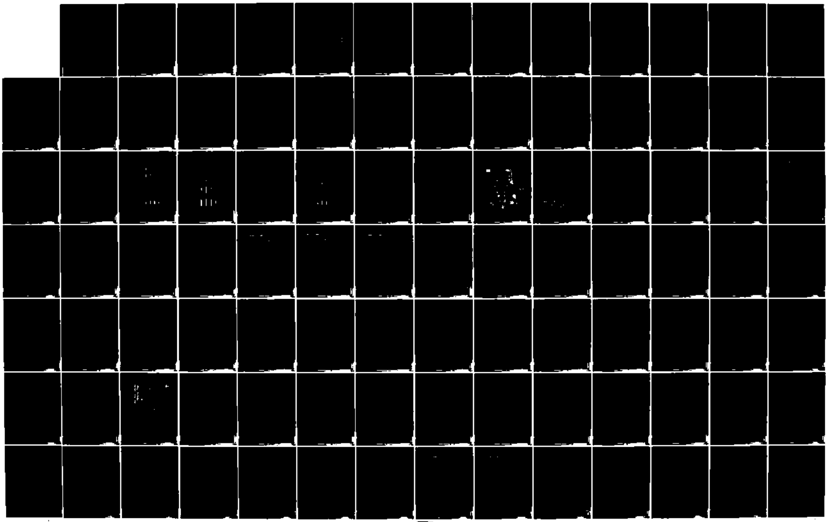
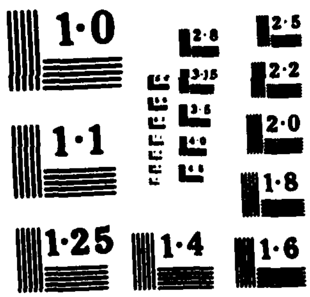
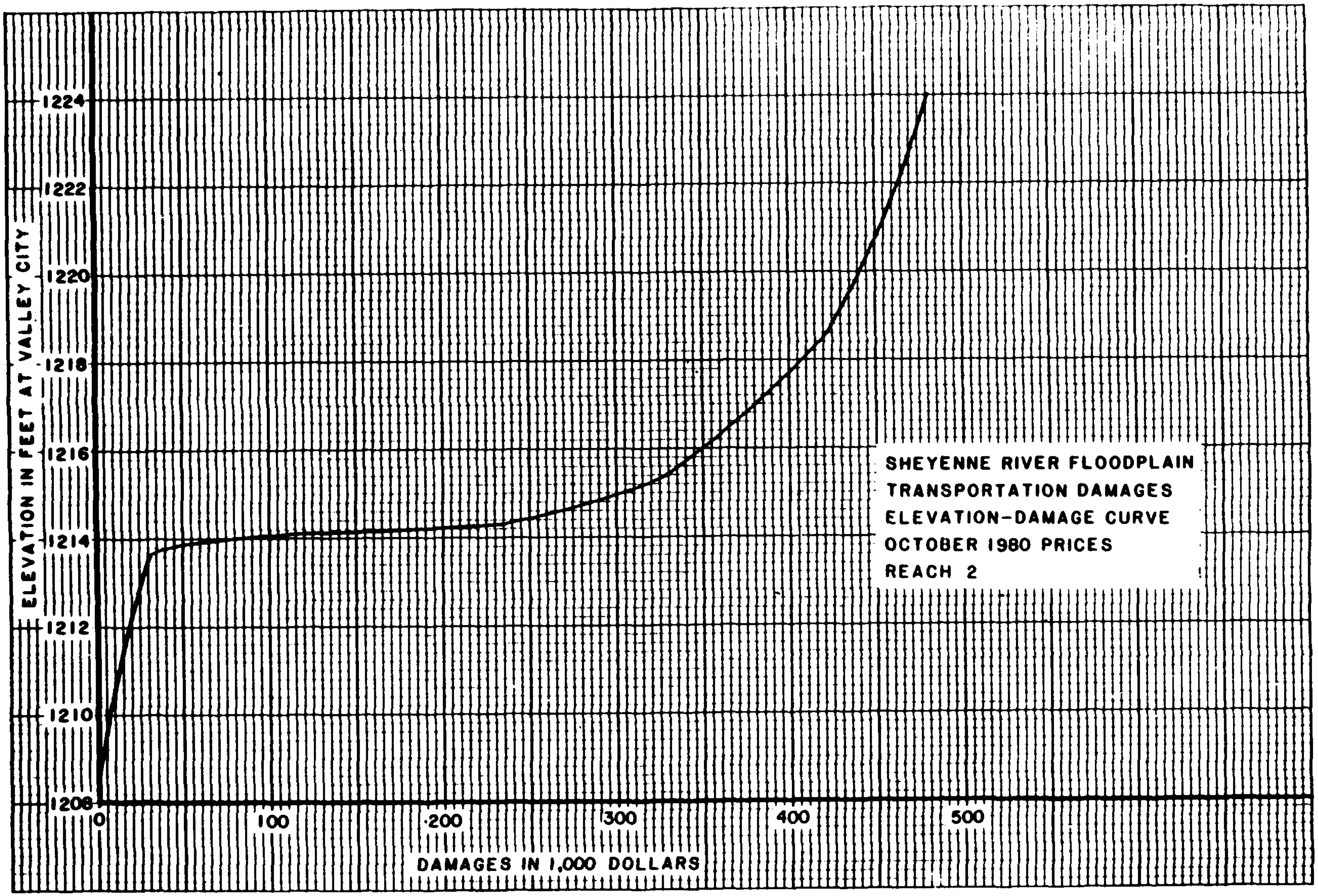
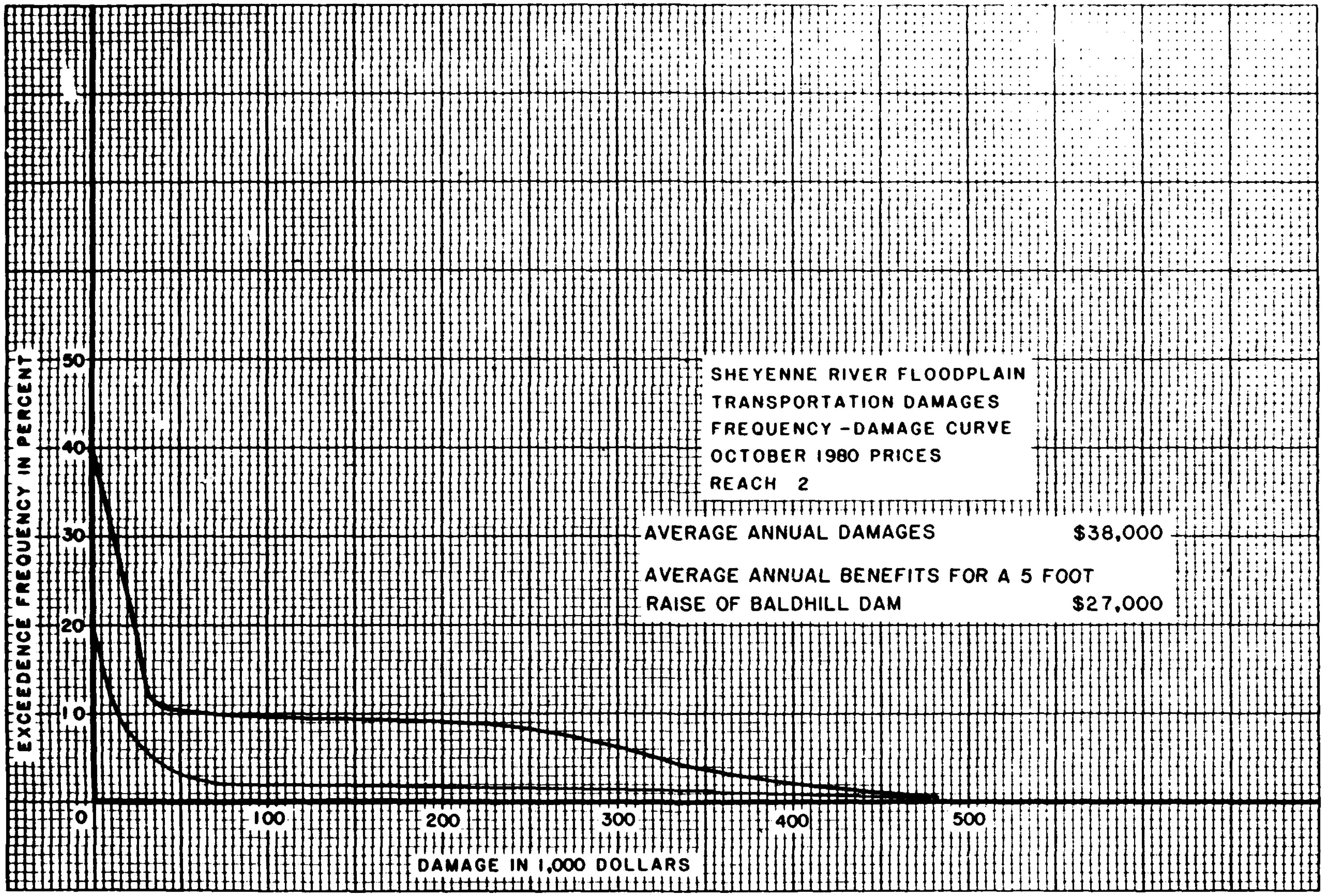
UNCLASSIFIED F/G 13/2 NL

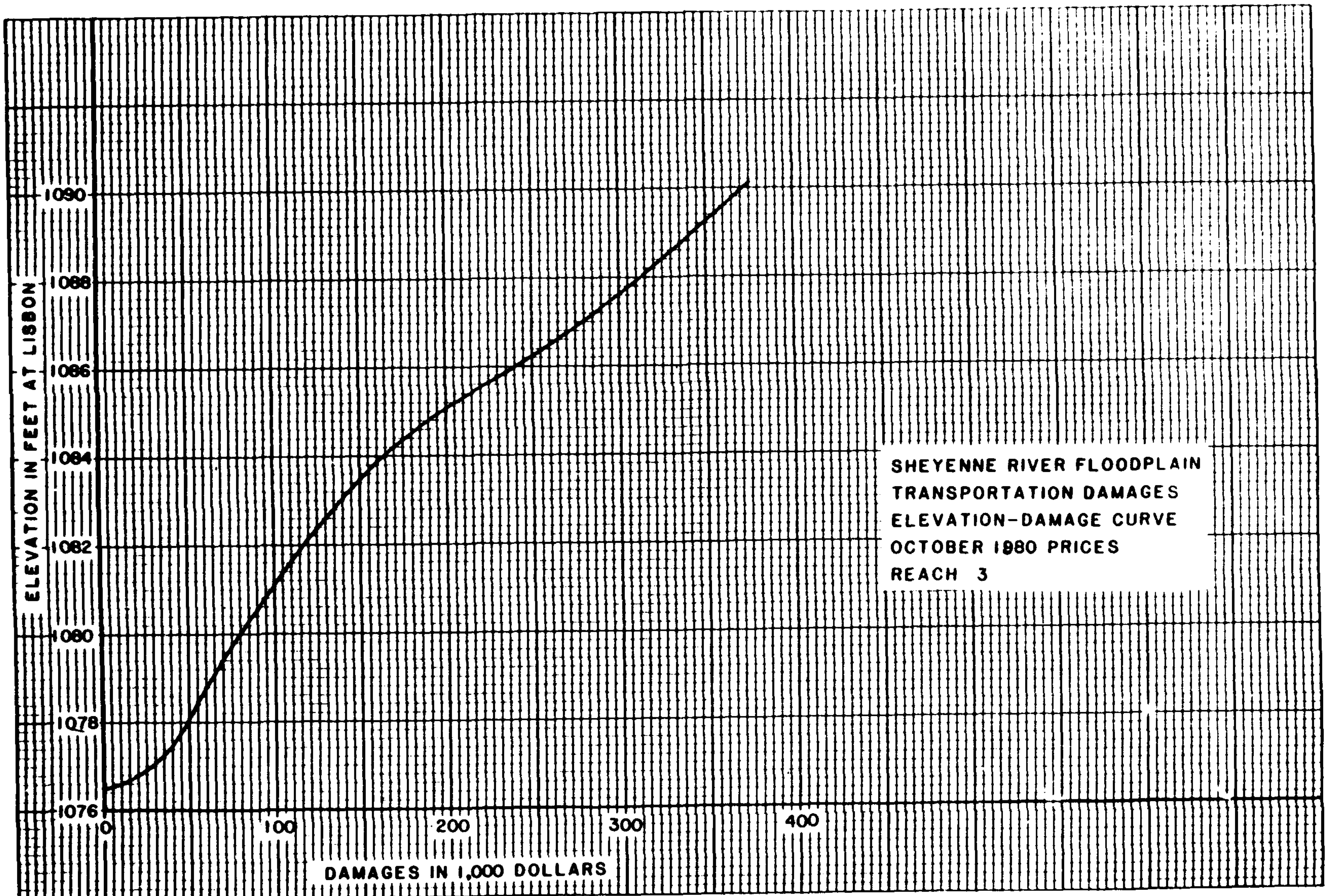



1·0
2·8
2·5
3·2
2·2
3·6
2·0
4·0
1·1
1·8
1·25
1·4
1·6


SHEYENNE RIVER FLOODPLAIN
TRANSPORTATION DAMAGES
ELEVATION-DAMAGE CURVE
OCTOBER 1980 PRICES
REACH 2
ELEVATION IN FEET AT VALLEY CITY
1224
1222
1220
1218
1216
1214
1212
1210
1208
0
100
200
300
400
500
DAMAGES IN 1,000 DOLLARS

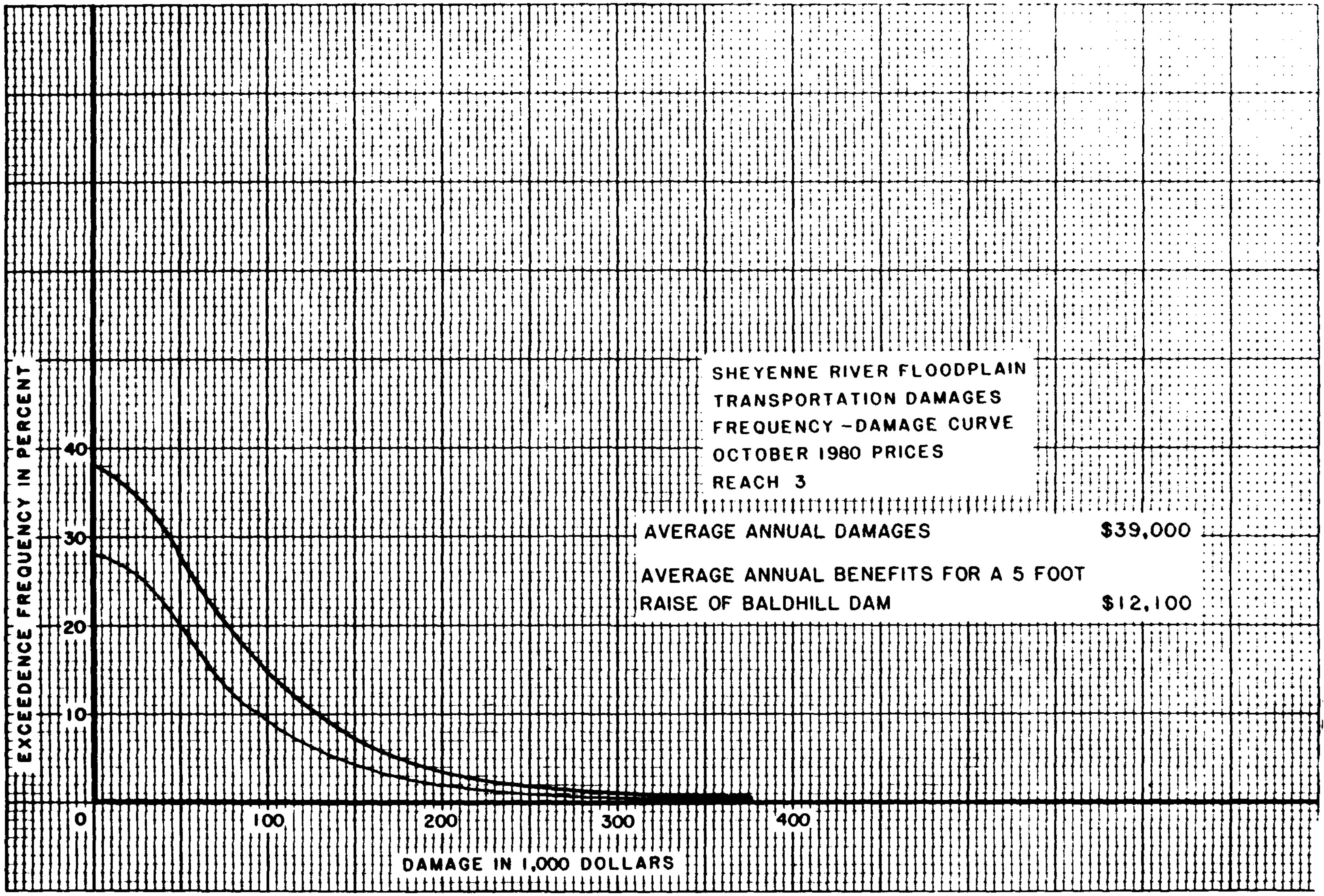


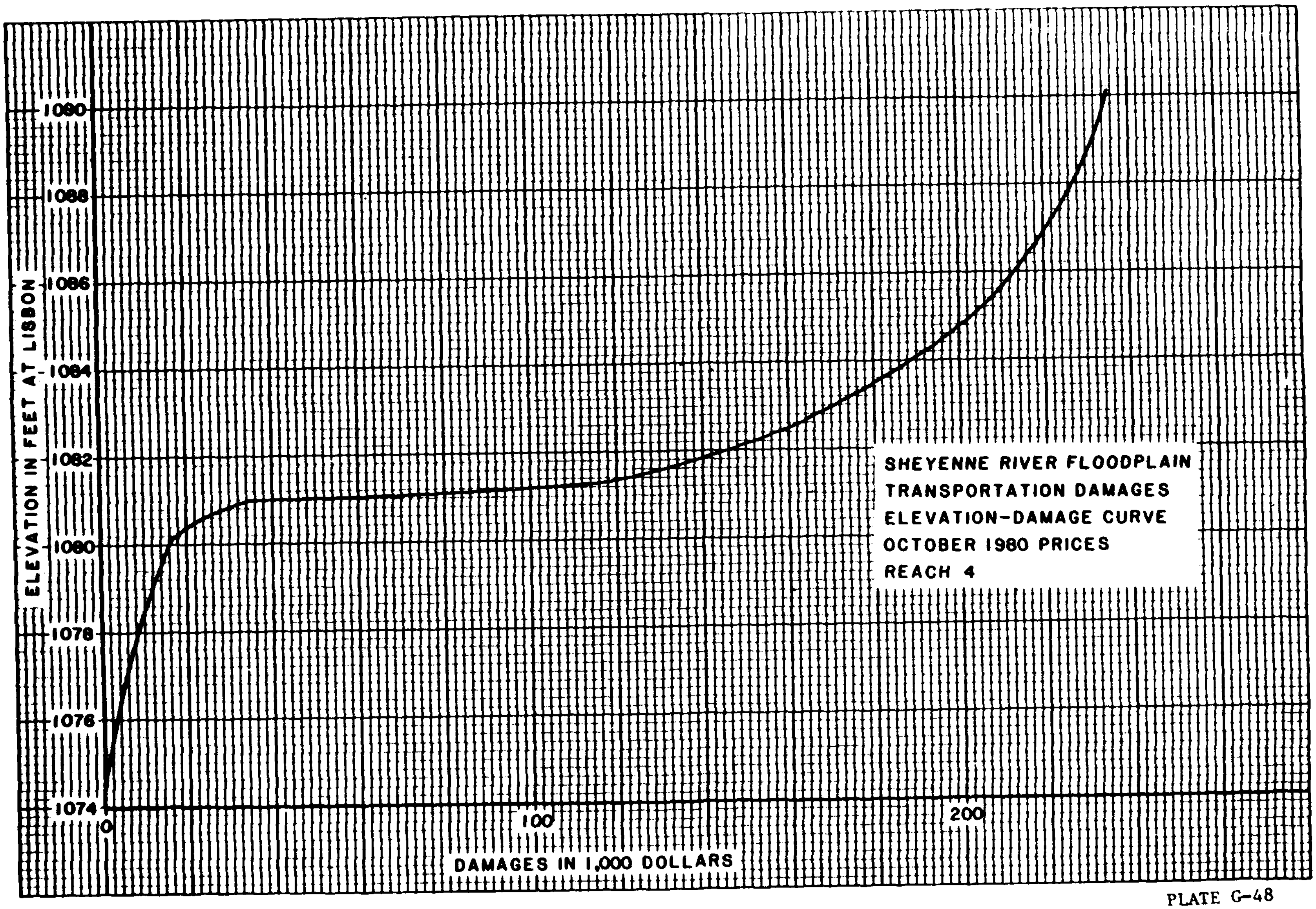
SHEYENNE RIVER FLOODPLAIN
TRANSPORTATION DAMAGES
FREQUENCY -DAMAGE CURVE
OCTOBER 1980 PRICES
REACH 2
AVERAGE ANNUAL DAMAGES $38,000
AVERAGE ANNUAL BENEFITS FOR A 5 FOOT
RAISE OF BALDHILL DAM $27,000
EXCEEDENCE FREQUENCY IN PERCENT
0
10
20
30
40
50
100
200
300
400
500
DAMAGE IN 1,000 DOLLARS

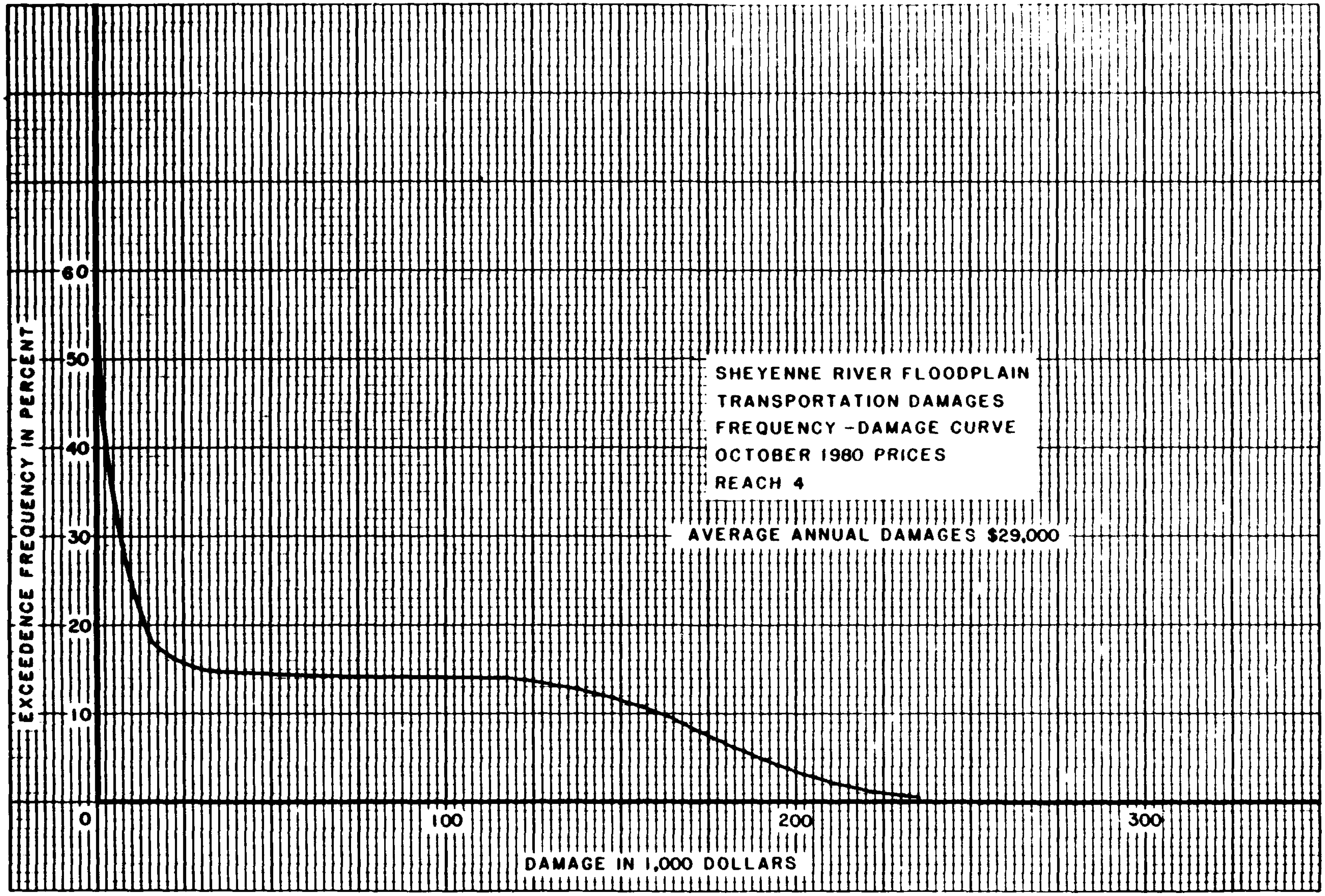


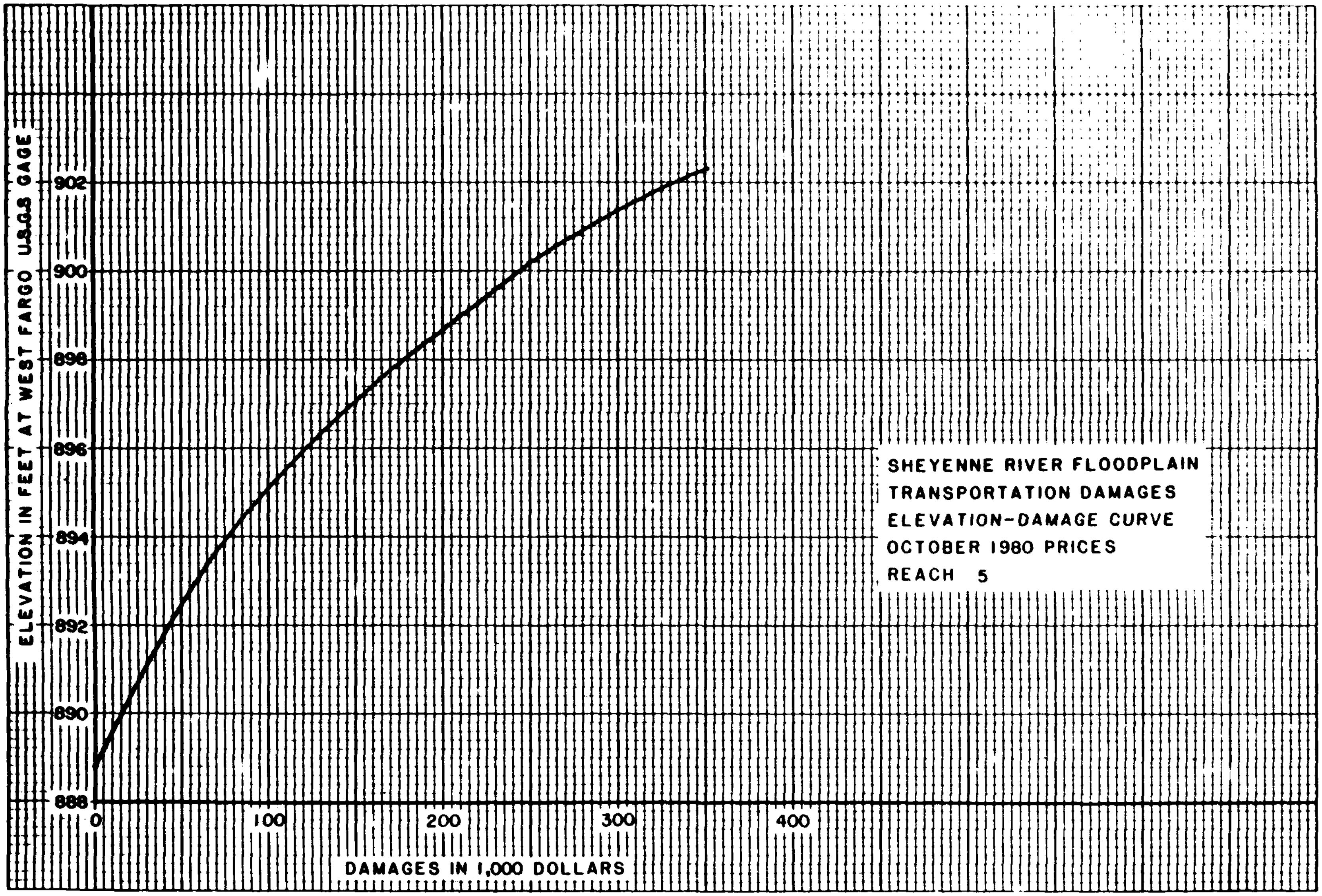
SHEYENNE RIVER FLOODPLAIN
TRANSPORTATION DAMAGES
ELEVATION-DAMAGE CURVE
OCTOBER 1980 PRICES
REACH 3
ELEVATION IN FEET AT LISBON
1076
1078
1080
1082
1084
1086
1088
1090
DAMAGES IN 1,000 DOLLARS
0
100
200
300
400

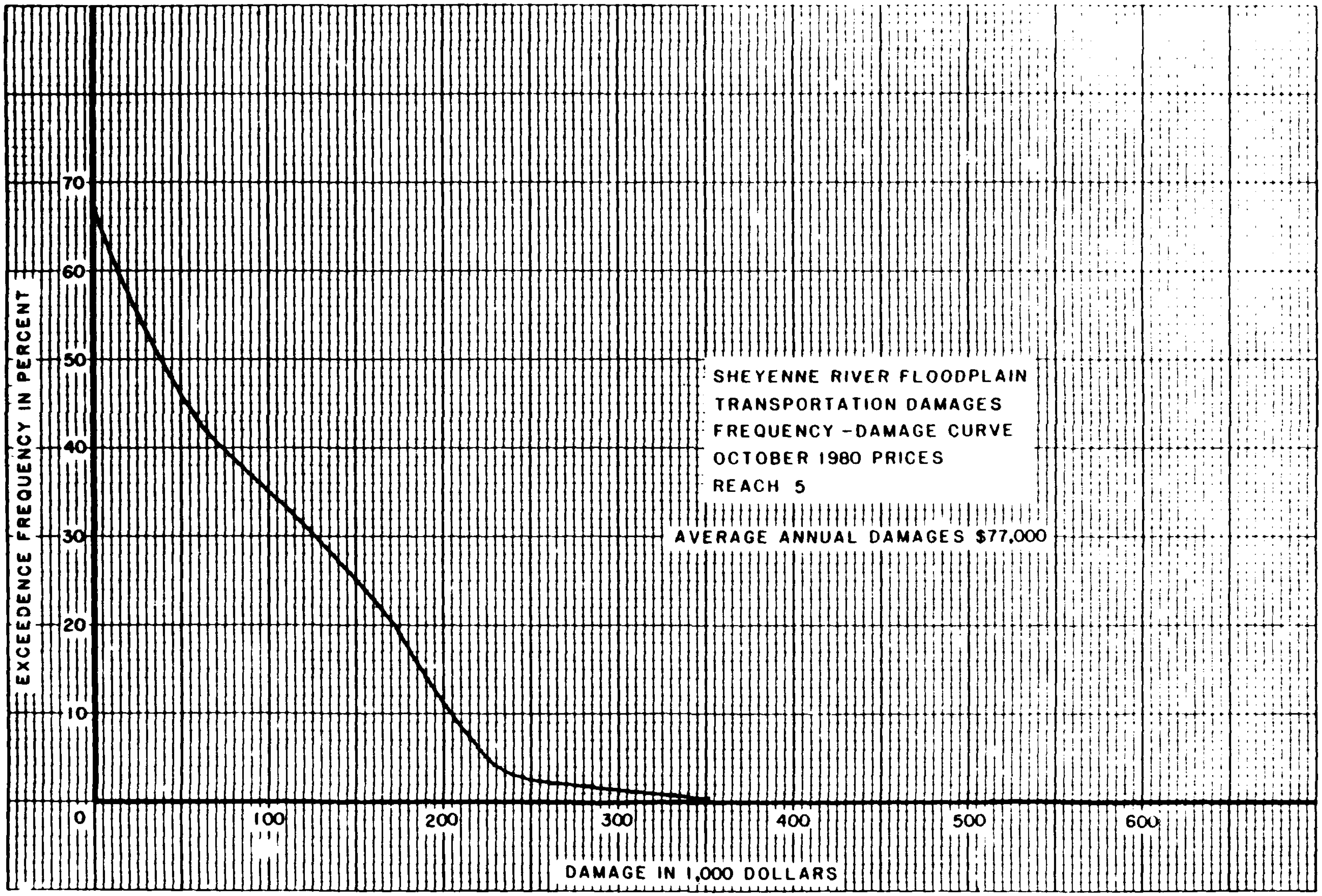
PLATE G-46


SHEYENNE RIVER FLOODPLAIN
TRANSPORTATION DAMAGES
FREQUENCY - DAMAGE CURVE
OCTOBER 1980 PRICES
REACH 3
AVERAGE ANNUAL DAMAGES $39,000
AVERAGE ANNUAL BENEFITS FOR A 5 FOOT
RAISE OF BALDHILL DAM $12,100
EXCEEDENCE FREQUENCY IN PERCENT
40
30
20
10
0
100
200
300
400
DAMAGE IN 1,000 DOLLARS


SHEYENNE RIVER FLOODPLAIN
TRANSPORTATION DAMAGES
ELEVATION-DAMAGE CURVE
OCTOBER 1980 PRICES
REACH 4
ELEVATION IN FEET AT LISBON
1090
1088
1086
1084
1082
1080
1078
1076
1074
0
100
200
DAMAGES IN 1,000 DOLLARS


SHEYENNE RIVER FLOODPLAIN
TRANSPORTATION DAMAGES
FREQUENCY - DAMAGE CURVE
OCTOBER 1980 PRICES
REACH 4
AVERAGE ANNUAL DAMAGES $29,000
EXCEEDENCE FREQUENCY IN PERCENT
60
50
40
30
20
10
0
100
200
300
DAMAGE IN 1,000 DOLLARS


SHEYENNE RIVER FLOODPLAIN
TRANSPORTATION DAMAGES
ELEVATION-DAMAGE CURVE
OCTOBER 1980 PRICES
REACH 5
ELEVATION IN FEET AT WEST FARGO U.S.G.S GAGE
888
890
892
894
896
898
900
902
0
100
200
300
400
DAMAGES IN 1,000 DOLLARS


SHEYENNE RIVER FLOODPLAIN
TRANSPORTATION DAMAGES
FREQUENCY -DAMAGE CURVE
OCTOBER 1980 PRICES
REACH 5
AVERAGE ANNUAL DAMAGES $77,000
EXCEEDENCE FREQUENCY IN PERCENT
70
60
50
40
30
20
10
0
100
200
300
400
500
600
DAMAGE IN 1,000 DOLLARS

APPENDIX H

WATER QUALITY

GENERAL REEVALUATION

AND

ENVIRONMENTAL IMPACT STATEMENT

SHEYENNE RIVER, NORTH DAKOTA

AUGUST 1982

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APPENDIX H

WATER QUALITY ANALYSIS

INTRODUCTION

The water quality of the Sheyenne River is discussed in this section. Present conditions and potential changes due to the various flood control alternatives are evaluated. Emphasis is given to Lake Ashtabula and proposed Kindred Lake because impoundments are the only features among the alternatives which would result in significant changes in water quality.

SHEYENNE RIVER WATER QUALITY MONITORING

The location of sampling stations, frequency of sampling and parameters being taken are shown in Table H-1.

The Cooperstown, Baldhill Creek and below Baldhill Dam sampling stations were upgraded during 1979-1981 primarily for the purpose of Lake Ashtabula water quality investigations. The program was discontinued as of September 1981. The sampling station at Kindred was supported by the Corps of Engineers during 1976-1980. The program was designed to provide the necessary data base to conduct mathematical water quality model studies of the proposed Kindred Lake alternatives. Plans to conduct these modeling studies have since been dropped.

LAKE ASHTABULA WATER QUALITY MONITORING

In addition to the river sampling at Cooperstown, Baldhill Creek and below Baldhill Dam described above, the Corps' ongoing water quality investigations of Lake Ashtabula also included lake sampling during 1981. The lake was sampled at seven sites eleven times during the early spring and mid-summer. The parameters monitored included nutrients, total solids, volatile solids, organic carbon, turbidity, chlorophyll a and b, temperature, specific conductance, dissolved oxygen, secchi disc transparency and pH. The sampling program, including the river and lake sampling, was designed to provide the necessary data base to calibrate a mathematical water quality computer model so that various reservoir operational and water quality management techniques may be evaluated by means of mathematical simulations.

Table H-1- Summary of water quality data, Sheyenne River, North Dakota[1]

Parameters measured	Baldhill Creek near Dazey	Warwick	Cooperstown[2]	Lake Ashtabula	Below Baldhill Dam	Valley City	Little Yellowstone/ Fort Ransom	Lisbon	Kindred[3]	West Fargo	Harwood
Discharge	C	-	C	-	C	M	-	D	C	C	-
Temperature	M	M	C	O	M	M	-	D	C	C	M
Conductivity	M	M	C	O	M	M	O	D	C	C	M
pH	M	M	W	O	M	SA	O	M	-	SA	M
Dissolved Oxygen	M	M	W	O	M	Q	-	M	-	W	M
D.O., Percent of Saturation	-	-	W	-	-	-	-	-	-	-	M
BOD	M	M	W	-	M	Q	-	M	-	W	M
Standard Chemical Analysis											
Alkalinity	M	M	W	O	M	SA	O	M	-	SA	A
Bicarbonate	M	-	W	-	M	SA	-	M	-	SA	A
Calcium	M	M	W	O	M	SA	-	M	-	SA	M
Chloride	M	M	W	O	M	SA	O	M		SA	M
Color	M	Q	W	O	M	O	-	M	-	-	O
Dissolved Solids, Total	M	Q	W	O	M	SA	O	M	-	M	A
Dissolved Solids, T/Day	M	M	W	-	M	SA	-	M	-	M	M
Dissolved Solids, T/AF	M	M	W	O	M	SA	-	M	-	M	M
Flouride, Dissolved	M	Q	W	O	M	SA	-	M	-	SA	Q
Iron, Total	M	O	W	O	M	O	O	Q	-	SA	Q
Iron, Dissolved	M	Q	W	O	M	SA	-	A	-	O	Q
Magnesium, Dissolved	M	M	W	O	M	SA	-	M	-	SA	M
Manganese, Total	M	Q	W	O	M	-	O	SA	-	M	-
Manganese, Dissolved	M	O	W	O	M	SA	-	O	-	SA	Q
Potassium	M	M	W	-	M	SA	-	M	-	SA	Q
Silica	M	Q	W	O	M	SA	-	M	-	SA	-
Sodium	M	O	W	O	M	SA	-	M	-	SA	Q
Sulfate	M	M	W	O	M	SA	O	M	-	SA	M
Turbidity	M	-	W	O	M	O	-	-	-	O	M
Hardness	M	O	W	O	M	SA	O	M	-	SA	M
Sodium, Percent	M	O	W	O	M	SA	-	M	-	SA	Q
SAR	M	-	W	-	M	SA	-	M	-	SA	A
Nutrients											
Ammonia, Diss. as N	M	-	W	-	M	-	-	-	-	-	M
Ammonia, Total as N	M	-	W	O	M	SA	-	-	-	-	Q
Nitrite, Total	M	O	W	O	M	-	-	-	-	-	-
Nitrite, Diss. as N	M	M	W	-	M	-	-	M	-	-	M
Nitrate, Total	M	Q	W	-	M	SA	O	O	-	-	O
Nitrate, Diss. as N	M	-	W	O	M	SA	-	Q	-	SA	-
Nitrate, Total as N	M	-	W	O	M	-	-	-	-	-	-
Nitrite plus Nitrate, Total as N	M	-	W	-	M	-	-	M	-	M	-
Kjeldahl N, Diss. as N	M	-	W	-	M	-	-	-	-	-	-
Kjeldahl N, Total as N	M	-	W	O	M	-	-	-	-	O	-
Phosphorus, Diss. as P	M	M	W	-	M	-	-	M	-	M	M
Phosphorus, Total as P	M	-	W	O	M	-	-	-	-	O	M
Phosphorus, Diss. Ortho as P	M	O	W	O	M	SA	-	-	-	SA	M
Phosphorus, Total Org. as P	M	-	W	-	M	-	-	-	-	-	-
Phosphorus, Diss. Org. as P	M	-	W	-	M	-	-	-	-	-	-
Phosphorus, Total as PO4	M	-	W	O	M	O	O	O	-	-	O
Phosphorus, Diss. Ortho as PO4	M	-	W	-	M	-	-	-	-	O	-
Phosphorus, Hydrolyzable	M	-	W	-	M	-	-	-	-	-	-
Minor Elements											
Aluminum, Dissolved	-	O	A	-	-	-	-	A	-	-	M
Arsenic, Dissolved	-	-	A	-	-	-	-	A	-	-	Q
Barium, Dissolved	-	-	A	-	-	-	-	A	-	-	Q
Beryllium, Dissolved	-	-	A	-	-	-	-	A	-	-	Q
Boron, Dissolved	-	-	M	-	SA	SA	-	A	-	SA	Q
Cadmium, Dissolved	-	-	A	-	-	-	O	A	-	-	Q
Carbon, Dissolved Organic	-	-	-	-	-	-	-	-	-	-	-
Carbon, Suspended Organic	-	-	-	-	-	-	-	-	-	-	-
Chromium, Dissolved	-	-	A	-	-	-	-	A	-	-	Q
Cobalt, Dissolved	-	-	A	-	-	-	-	A	-	-	Q
Copper, Dissolved	-	-	A	-	-	-	O	A	-	-	Q
Cyanide, Total	-	Q	A	-	-	-	-	A	-	-	-
Lead, Dissolved	-	-	A	-	-	-	O	A	-	-	Q
Lithium, Dissolved	-	-	A	-	-	-	-	A	-	-	-
Mercury, Dissolved	-	-	A	-	-	-	-	A	-	-	Q
Molybdenum, Dissolved	-	-	A	-	-	-	-	A	-	-	-
Nickel, Dissolved	-	-	A	-	-	-	-	A	-	-	Q
Selenium, Dissolved	-	-	A	-	-	-	-	A	-	-	Q
Silver, Dissolved	-	-	A	-	-	-	-	A	-	-	Q
Strontium, Dissolved	-	-	A	-	-	-	-	A	-	-	Q
Vanadium, Dissolved	-	O	A	-	-	-	-	A	-	-	Q
Zinc, Dissolved	-	-	A	-	-	-	O	A	-	-	Q
Bacteriology											
Fecal Coliform	M	M	W	-	O	O	O	M	-	D	M
Total Coliform	M	M	W	-	O	Q	O	M	-	D	M
Fluvial Sediment											
Suspended Sediment Concentration	-	-	-	-	-	-	-	-	D	-	-
Suspended Sediment Discharge	-	-	-	-	-	-	-	-	D	-	-
[illegible] Material	-	-	-	-	-	-	-	-	Q	-	-
Sediment, Suspended	-	-	-	-	-	-	-	-	Q	-	-
Pesticide Analysis	-	-	-	-	-	-	-	-	O	-	O

(1) Data have been or are being collected at these locations for the parameters noted based on the following legend: C = Continuous; D = Daily; W = Weekly; M = Monthly; Q = Quarterly; SA = Semiannual; A = Annual; O = Other. Also note that years of data collected vary.

(2) Weekly data are obtained from March - September; monthly data from October - February. During low-flow periods, data were collected on a monthly basis.

(3) Weekly data are available on many parameters at the Kindred location from 1976 through 1979.

EXISTING CONDITIONS

The Sheyenne River has been classified by the State of North Dakota as a Class 1A stream which is defined in Regulation 61-28-02, Standards of Water Quality for State of North Dakota, as follows:

"The quality of waters in this class shall be such as to permit the propagation and/or life of resident fish species and shall be suitable for boating, swimming, and other water recreation. In addition, the quality shall be such that after proper treatment, which may also require softening, the treated water shall meet the State Health Department's bacteriological, physical, and chemical requirements for municipal use. The quality of water shall also be such as to permit use of the water for irrigation, stock watering, and wildlife without injurious effects."

The requirements for Class 1A streams are shown in Table H-2. Radiological criteria are not shown.

Tables H-3, H-4 and H-5 present summaries of violations of state water quality standards observed at the Cooperstown, Baldhill Dam and Kindred sampling stations respectively during the period of record. Some parameters which do not have applicable standards were also requested in the computerized flagging scan, which is why these parameter headings also appear on the summary sheets. For the fecal coliform parameter the criterion 200 per 100 ml maximum was used but it should be noted that occasional grab samples, as these were, containing greater than 200/ml do not necessarily indicate a violation of the standard (see Table H-1).

At the Cooperstown station the standard most frequently violated is dissolved phosphorus. The total cyanide standard was violated 4 times out of 17 observations. Other standards which were occasionally violated are dissolved oxygen, pH, ammonia (NH_3-NH_4), nitrate (NO_3-N), sulfate and boron.

Table H-2 - Class 1A water quality requirements

Storet code	Substance or characteristic	Limitation
00608	Ammonia (un-ionized) as (N) (diss.)	.02 mg/l
01002	Arsenic (total)	.05 mg/l
01005	Barium (diss.)	1.0 mg/l
01020	Boron (diss.)	.5 mg/l
01027	Cadmium (total)	.01 mg/l
00940	Chlorides (diss.)	175 mg/l
01034	Chromium (total)	.05 mg/l
01042	Copper (total)**	.05 mg/l
00720	Cyanides (total)	.005mg/l
01049	Lead (diss.)**	.05 mg/l
00618	Nitrates (N) (diss.)*	1.0 mg/l
00666	Phosphates (P) (diss.)*	0.1 mg/l
01092	Zinc (total)**	1.0 mg/l
01147	Selenium (total)	.01 mg/l
39516	Polychlorinated biphenyls (total)	.001ug/l
00300	Dissolved oxygen	not less than 5.0 mg/l
00403	pH	7.0 - 8.5
00010	Temperature	85°F. The maximum increase shall not be greater than 5°F above natural background conditions.
31616	Fecal coliform	Shall not exceed a geometric mean of 200 fecal coliforms per 100 ml based on a minimum of not less than five samples obtained during separate 24-hour periods for any 30-day period, nor shall 10 percent of total samples exceed 400 fecal coliforms per 100 ml. This standard shall apply only during the recreation season, 1 May to 30 September.
00929	Sodium	60 percent of total cations as mEq/l.
32730	Phenols	.01 mg/l
00945	Sulfates (diss.)	450 mg/l
50060	Total chlorine residual	.01 mg/l
71900	Mercury (total)	.002mg/l

* The standards for nitrates and phosphates are intended as guideline limits. Since each stream or lake has unique characteristics which determine the levels of these constituents that will cause excessive algae growth (eutrophication) the Department reserves the right to review these standards after additional study and to set specific limitations on any waters of the State. No standard will be modified without adequate regional public notification, hearing and opportunity for comment. However, in no case shall the standard for nitrates (N) exceed 10 mg/l for any waters used as a municipal or domestic drinking water supply.

**More restrictive criteria than specified may be necessary to protect fish and aquatic life. These criteria will be developed according to the procedures in 02.702(2).

TABLE H-3

STORET RETRIEVAL DATE 81/09/08 - STAND - VERSION OF JUN. 1981 SIN 1.SUMMARY.1

THIS RETRIEVAL IDENTIFIES SPECIFIC PARAMETRIC VALUES WHICH DO NOT CONFORM TO STATE STANDARDS FOR THE STATE OF NORTH DAKOTA. DATA ARE FROM THE STORET DATABANK.

05057000
47 26 01.0 098 01 43.0 2
SHEYENNE RIVER NR COOPERSTOWN, ND
38039 NORTH DAKOTA GW7GGS
070191

/TYPA/AMBNT/STREAM

112WRD
0000 FEET DEPTH CLASS 00 CSN=WSP 0017RAR-0221590

SUMMARY OF VIOLATIONS ON SAMPLES COLLECTED FROM 59/10/11 TO 81/06/23

	00010 WATER TEMP CENT	00061 STREAM FLOW, INST-CFS	00300 DO MG/L	00400 PH SU	00608 NH3+NH4- N DISS MG/L	00619 UN-IONZD NH3-NH3 MG/L	00940 CHLORIDE TOTAL MG/L	31625 FEC COLI M-FCAGAR /100 ML	31673 FECSTREP MKFAGAR /100ML	82028 RATIO FEC COL FEC STRP
NO OF VALUES	247	148	65	331	65	64	268	63	60	62
MEAN	9.	239.	8.309	7.918	0.	0.0040	16.2	128.1	492.	3.
MEDIAN	7.	32.	8.200	7.900	0.	0.0022	17.0	23.0	105.	0.
NO OF VIOLS	0	0	8	14	0	1	0	5	0	0
PERCENT VIOL	0.	0.	12.	4.	0.	2.	0.	8.	0.	0.
MINIMUM VIOL	0.	0.	3.000	6.500	0.	0.0293	0.0	470.0	0.	0.
MEAN VIOL	0.	0.	3.987	8.179	0.	0.0293	0.0	1142.0	0.	0.
MAXIMUM VIOL	0.	0.	4.600	8.700	0.	0.0293	0.0	2300.0	0.	0.
MIN CRITERIA	*********	*********	5.000	7.000	*********	*********	*********	*********	*********	*********
MAX CRITERIA	*********	*********	*********	8.500	*********	0.0200	100.0	200.0	*********	*********

	00613 NO2-N DISS MG/L	00666 PHOS-DIS MG/L P	00945 SULFATE SO4-TOT MG/L	39516 PCBS WHL SMPL UG/L	00720 CYANIDE CN-TOT MG/L	01002 ARSENIC AS,TOT UG/L	01005 BARIUM BA,DISS UG/L	01020 BORON B,DISS UG/L	01049 LEAD PB,DISS UG/L
NO OF VALUES	119	169	282	0	17	0	22	268	21
MEAN	0.192	0.159	143.1	0.	0.0029	0.0	31.	179.9	2.57
MEDIAN	0.060	0.150	140.0	0.	0.0	0.0	0.	180.0	1.00
NO OF VIOLS	4	135	5	0	4	0	0	1	0
PERCENT VIOL	3.	80.	2.	0.	24.	0.	0.	0.	0.
MINIMUM VIOL	1.100	0.100	258.0	0.	0.0100	0.0	0.	890.0	0.0
MEAN VIOL	1.300	0.195	291.2	0.	0.0125	0.0	0.	890.0	0.0
MAXIMUM VIOL	1.700	0.780	360.0	0.	0.0200	0.0	0.	890.0	0.0
MIN CRITERIA	*********	*********	*********	*********	*********	*********	*********	*********	*********
MAX CRITERIA	1.000	0.100	250.0	*********	0.0050	50.00	1000.	500.0	50.00

TABLE H-4

STORET RETRIEVAL DATE 81/09/08 - STAND - VERSION OF JUN. 1981 STG 2.SUMMARY.1

THIS RETRIEVAL IDENTIFIES SPECIFIC PARAMETRIC VALUES WHICH DO NOT CONFORM TO STATE STANDARDS FOR THE STATE OF NORTH DAKOTA. DATA ARE FROM THE STORET DATABANK.

05058000
47 01 50.0 098 05 50.0 2
SHEYENNE RIVER BELOW BALDHILL DAM, ND
38003 NORTH DAKOTA BARNES
070191

/TYPA/AMBNT/STREAM

112WRD
0000 FEET DEPTH CLASS 00 CSN-RSP 0113950-0221654

SUMMARY OF VIOLATIONS ON SAMPLES COLLECTED FROM 59/06/05 TO 81/06/10

	00010 WATER TEMP CENT	00061 STREAM FLOW, INST-CFS	00300 DO MG/L	00400 PH SU	00608 NH3+NH4- N DISS MG/L	00619 UN-IONZD NH3-NH3 MG/L	00940 CHLORIDE TOTAL MG/L	31625 FEC COLI M-FCAGAR /100 ML	31673 FECSTREP MENFAGAR /100ML	82028 RATIO FEC COL FEC STRP
NO OF VALUES	128	93	26	76	26	26	78	26	26	26
MEAN	10.	220.	10.788	8.083	0.	0.0127	13.3	11.3	187.	1.
MEDIAN	7.	43.	10.800	7.950	0.	0.0083	13.0	2.0	12.	0.
NO OF VIOLS	0	0	0	18	0	6	0	0	0	0
PERCENT VIOL	0.	0.	0.	24.	0.	23.	0.	0.	0.	0.
MINIMUM VIOL	0.	0.	0.0	6.900	0.	0.0214	0.0	0.0	0.	0.
MEAN VIOL	0.	0.	0.0	8.678	0.	0.0306	0.0	0.0	0.	0.
MAXIMUM VIOL	0.	0.	0.0	9.100	0.	0.0441	0.0	0.0	0.	0.
MIN CRITERIA	*********	*********	5.000	7.000	*********	*********	*********	*********	*********	*********
MAX CRITERIA	*********	*********	*********	8.500	*********	0.0200	100.0	200.0	*********	*********

	00618 NO3-N DISS MG/L	00666 PHOS-DIS MG/L P	00945 SULFATE SO4-TOT MG/L	39516 PCBS WHL SMPL UG/L	00720 CYANIDE CN-TOT MG/L	01002 ARSENIC AS,TOT UG/L	01005 BARIUM BA,DISS UG/L	01020 BORON B,DISS UG/L	01049 LEAD PB,DISS UG/L
NO OF VALUES	43	26	78	0	0	0	0	78	0
MEAN	0.283	0.160	110.2	0.	0.0	0.0	0.	139.4	0.0
MEDIAN	0.110	0.160	108.5	0.	0.0	0.0	0.	140.0	0.0
NO OF VIOLS	2	20	0	0	0	0	0	0	0
PERCENT VIOL	5.	77.	0.	0.	0.	0.	0.	0.	0.
MINIMUM VIOL	1.500	0.100	0.0	0.	0.0	0.0	0.	0.0	0.0
MEAN VIOL	1.850	0.186	0.0	0.	0.0	0.0	0.	0.0	0.0
MAXIMUM VIOL	2.200	0.288	0.0	0.	0.0	0.0	0.	0.0	0.0
MIN CRITERIA	*********	*********	*********	*********	*********	*********	*********	*********	*********
MAX CRITERIA	1.000	0.100	250.0	*********	0.0050	50.00	1000.	500.0	50.00

TABLE H-5

STORET RETRIEVAL DATE 81/09/08 - STAND - VERSION OF JUN. 1981 STN 1,SUMMARY,1

THIS RETRIEVAL IDENTIFIES SPECIFIC PARAMETRIC VALUES WHICH DO NOT CONFORM TO STATE STANDARDS FOR THE STATE OF NORTH DAKOTA. DATA ARE FROM THE STORET DATABANK.

05059000
46 37 35.0 097 00 05.0 2
SHEYENNE RIVER NR KINDRED, ND
38077 NORTH DAKOTA RICHLAND
070191

/TYPA/AMBNT/STREAM

112WRD
0000 FEET DEPTH CLASS 00 CSP-RSP 0120143-0221727

SUMMARY OF VIOLATIONS ON SAMPLES COLLECTED FROM 71/10/13 TO 81/04/27

	00010 WATER TEMP CENT	00061 STREAM FLOW, INST-CFS	00300 DO MG/L	00400 PH SU	00608 NH3+NH4- N DISS MG/L	00619 UN-IONZD NH3-NH3 MG/L	00940 CHLORIDE TOTAL MG/L	31625 FEC COLI M-FCAGAD /100 ML	31673 FECSTREP MENFAGAR /100ML	82028 RATIO FEC COL FEC STRP
NO OF VALUES	283	157	109	136	119	118	123	65	50	48
MEAN	10.	454.	8.167	8.066	0.	0.0019	31.5	325.3	792.	1.
MEDIAN	9.	90.	8.000	8.100	0.	0.0006	31.0	92.0	287.	0.
NO OF VIOLS	0	0	6	1	0	1	0	17	0	0
PERCENT VIOL	0.	0.	6.	1.	0.	1.	0.	26.	0.	0.
MINIMUM VIOL	0.	0.	4.800	8.500	0.	0.0288	0.0	210.0	0.	0.
MEAN VIOL	0.	0.	4.567	8.500	0.	0.0288	0.0	1031.2	0.	0.
MAXIMUM VIOL	0.	0.	5.000	8.500	0.	0.0288	0.0	5500.0	0.	0.
MIN CRITERIA	*********	*********	5.000	7.000	*********	*********	*********	*********	*********	*********
MAX CRITERIA	*********	*********	*********	8.500	*********	0.0200	100.0	200.0	*********	*********

	00618 NO3-N DISS MG/L	00666 PHOS-DIS MG/L P	00945 SULFATE SO4-TOT MG/L	39516 PCBS WHL SMPL UG/L	00720 CYANIDE CN-TOT MG/L	01002 ARSENIC AS,TOT UG/L	01005 BARIUM BA,DISS UG/L	01020 BORON B,DISS UG/L	01049 LEAD PB,DISS UG/L	71900 MERCURY HG,TOTAL UG/L
NO OF VALUES	119	119	123	5	18	26	18	34	12	26
MEAN	0.335	0.076	145.9	0.	0.2256	5.92	117.	868.2	1.00	4.192
MEDIAN	0.180	0.060	150.0	0.	0.0	5.00	100.	170.0	0.0	0.100
NO OF VIOLS	4	27	0	0	5	0	0	4	0	5
PERCENT VIOL	4.	23.	0.	0.	28.	0.	0.	12.	0.	19.
MINIMUM VIOL	1.300	0.100	0.0	0.	0.0100	0.0	0.	860.0	0.0	13.000
MEAN VIOL	1.400	0.141	0.0	0.	0.8120	0.0	0.	6215.0	0.0	21.200
MAXIMUM VIOL	1.600	0.300	0.0	0.	3.0000	0.0	0.	20000.0	0.0	40.000
MIN CRITERIA	*********	*********	*********	*********	*********	*********	*********	*********	*********	*********
MAX CRITERIA	1.000	0.100	250.0	*********	0.0050	50.00	1000.	500.0	50.00	2.000

At the Baldhill Dam station the dissolved phosphorus, ammonia and pH standards are frequently violated. The high pH and ammonia levels are probably related to photosynthetic activity of algae in Lake Ashtabula as observed by Peterka (1969).

At the Kindred station the phosphorus standard was violated often but less frequently than at the upstream stations. The cyanide standard was violated 5 times out of 18 observations. Other parameters which occasionally exceeded standards are dissolved oxygen, pH, ammonia, nitrate, boron and mercury.

The Tri College Center for Environmental Studies at Fargo, North Dakota, conducted a study which was designed to provide background information necessary to evaluate water resources development in the Sheyenne River Valley (Bromel, 1977). In that study the following observations were made:

a. The high phosphorus concentrations which are observed throughout the valley typically exceed levels thought to accelerate eutrophication of lakes. About 94 percent of the phosphorus loading is from nonpoint agricultural sources.

b. The most likely sources of high nitrate concentrations are heavy fertilization of crops and riverside pasturing of cattle. Nitrate and nitrite levels are far below toxicity levels for warmwater fish.

c. The mean total dissolved solids (TDS) concentration in the Sheyenne River for the period 1959-1977 is 595 mg/l. Some crops are sensitive to irrigation water containing greater than 500 mg/l TDS.

d. The bacterial quality of the river was described as poor, as evidenced by the presence of fecal coliforms and intestinal pathogens of both animal and human origin.

TROPHIC STATUS AND NUTRIENT LOADING OF LAKE ASHTABULA AND PROPOSED KINDRED LAKE

The "trophic status" of a lake usually refers to its present condition in the context of its continuing progression from a lacustrine ecosystem to an upland ecosystem through the process of ecological succession. In lake water quality studies the term has come to be used as a measure of the degree to which this natural process (eutrophication) has been or could be accelerated by the activities of man. A lake classified as "eutrophic" typically exhibits profuse algal and vascular plant growth and associated water quality problems.

One of the earliest and most recognized studies attempting to quantify the trophic status of lakes based on external nutrient loading was conducted by Vollenweider (1968). The Environmental Protection Agency used the Vollenweider approach in its National Eutrophication Survey in which Lake Ashtabula was found to have an annual accumulated total phosphorus loading of 1.46 grams per square meter or more than three times the loading, 0.44 grams per square meter, which is considered to be eutrophic or "dangerous" for Lake Ashtabula according to the Vollenweider criteria (EPA, 1976).

In a recently published EPA handbook (EPA, 1977) it is pointed out that if it is first determined that phosphorus is not the growth limiting nutrient then the Vollenweider relationship is not valid and should not be used.

For this report the average annual phosphorus and nitrogen loads for the Sheyenne River at Cooperstown and at Kindred were calculated and normalized for the period of record by means of a rating curve-flow duration method. The method was originally developed by the U.S. Bureau of Reclamation (Miller, 1951) for predicting sediment yield and is based on identifying the frequency of occurrence of different flows and determining the loading rate for specified flow intervals. The results of the loading calculations are shown below along with the EPA estimates for the Cooperstown station.

	Cooperstown (EPA)	Cooperstown	Kindred
Total Phosphorus (lb/day)	156.9	121.2	319.1
Total Nitrogen (lb/day)	1377.5	939.3	2086.3
N:P Ratio	8.77	7.75	6.54

The nitrogen-phosphorus (N:P) ratios are less than 10 but greater than 5 which means, according to EPA (1977), that aquatic plant growth is probably limited by neither phosphorus nor nitrogen singly but may be limited by both nutrients combined, and that the Vollenweider Relationship should not be used. It is more likely, however, that none of the nutrients or combinations of nutrients are limiting to algae because of the high magnitude of the nutrient loads. Peterka (1969) in his study of water quality in relation to algal productivity in Lake Ashtabula found no significant correlations between photosynthesis and the various nutrients. For Lake Ashtabula this means that some unknown but possibly large fraction of the nutrients flowing into the lake would have to be controlled before a significant reduction in algae productivity would be realized.

If Kindred Lake were constructed with a summer pool elevation of 970 ft msl it would be similar to Lake Ashtabula in many of the characteristics which affect water quality. These include shallow depth (39 ft max; 10 ft mean depth) and high exposure to wind which prevent thermal stratification from developing and similar inflowing water chemistry characteristics including ample nutrient load to support algal and macrophyte growth. An important difference between the two lakes is that the mean annual hydraulic residence time of Kindred Lake would be only 58 days whereas that of Lake Ashtabula is 289 days. The significance of the residence time factor is that the growing season might begin with an initially lower concentration of available nutrients in the pool due to the early displacement of the heavily nutrient laden "first flush" waters.

SUMMARY OF WATER QUALITY IMPACTS OF FLOOD DAMAGE REDUCTION ALTERNATIVES

Most of the features among the structural and nonstructural alternatives would have no permanent effect on water quality of the Sheyenne River. Among the nonstructural features, those which affect runoff characteristics such as better land use planning, enforcement of drainage laws and financial incentives to retain water on farm land would result in some minor improvement in water quality through reductions in erosion and nutrient loading.

Among the structural features, construction activities associated with diversions, channelization and water control structures could have temporary impacts on turbidity, erosion and sedimentation. The restoration of wetlands could result in some improvement in water quality by retaining and assimilating nutrients.

The feature that involves increasing the flood storage of Baldhill Dam would neither improve nor degrade the water quality of Lake Ashtabula. Most of the water quality problems at Lake Ashtabula occur during the summer and are related to the growth of algae and aquatic vascular plants. This profuse growth is the result of a seemingly inexhaustible supply of the nutrients nitrogen and phosphorus in the sediment and water column during the growing season. The proposed modification of flood control operations would result in a higher pool and longer detention time of water during the early spring. But in most cases, the pool elevation would return to the normal seasonal operating range before the start of the growing season without significantly changing the initial available nutrient supply.

The Kindred dry dam alternative would result in temporary water quality problems associated with erosion, sedimentation and possibly with algae when the period of drawdown extends into the summer.

The Kindred wet dam (Kindred Lake) alternative would probably result in a eutrophic lake with problems similar to those of Lake Ashtabula, including profuse algae and macrophyte growth, low winter dissolved oxygen concentrations and winterkill potential. The short hydraulic residence time relative to that of Lake Ashtabula could mean that the system would be more responsive to design and operational water quality management techniques.

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APPENDIX I

RECREATION RESOURCES ANALYSIS

GENERAL REEVALUATION

AND

ENVIRONMENTAL IMPACT STATEMENT

SHEYENNE RIVER, NORTH DAKOTA

AUGUST 1982

APPENDIX I

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INTRODUCTION

This appendix is a recreation resource analysis of the specific needs for recreation facilities in the Sheyenne River basin. Through existing Corps authorities, the recreation development concepts presented in this appendix can be implemented to meet some of these needs.

In future studies, detailed recreation plans will be prepared for the selected flood control plan to coordinate and solidify facility development for active Corps participation.

RECREATION RESOURCE ANALYSIS OF THE SHEYENNE RIVER VALLEY

EXISTING CONDITIONS

"In recent years the United States has been experiencing a very significant increase in the number of people participating in a variety of outdoor recreational activities. A similar trend is currently occurring in North Dakota and in its southeastern counties of Cass, Ransom, Richland, Sargent, Steele and Traill....

"The increase in American's participation in a variety of outdoor recreational pursuits is largely because of increasing populations, increased mobility, increased leisure time, and greater affluence. These factors also hold true within the Lake Agassiz Region."[1] (See figure 1).

The Sheyenne River valley, a unique scenic resource, is one of the few eastern North Dakota river valleys remaining for the most part in a natural state. The extensive wooded character (5 percent of the State's woodland acres) and high valley walls create an area of scenic and recreational value in contrast to the surrounding flat and treeless farmland. Current major recreational opportunities within the valley include hunting, trapping, fishing, canoeing, camping, hiking, snowmobiling and bicycling. A 110-mile section of the Sheyenne River is identified by the North Dakota State Outdoor Recreation Agency as a scenic canoeing river. A section of the valley between Anselm and Kindred is considered by Federal and State fish and game resource experts to be one of the best deer hunting areas in eastern North Dakota. The use of existing resources is limited by such major factors as poor public access, general lack of facilities, limited local financial resources, inadequate maintenance of existing facilities, poor water quality, and lack of coordinated regional planning between involved government agencies.

---

[1] "An Inventory and Guide to Outdoor Recreational Needs in the Lake Agassiz Region," The Lake Agassiz Regional Council, 1976, p. 1.

FIGURE 1a

ESTIMATED WATER-BASED RECREATION ACTIVITY DAYS
FOR NORTH DAKOTA PLANNING REGIONS 3-6

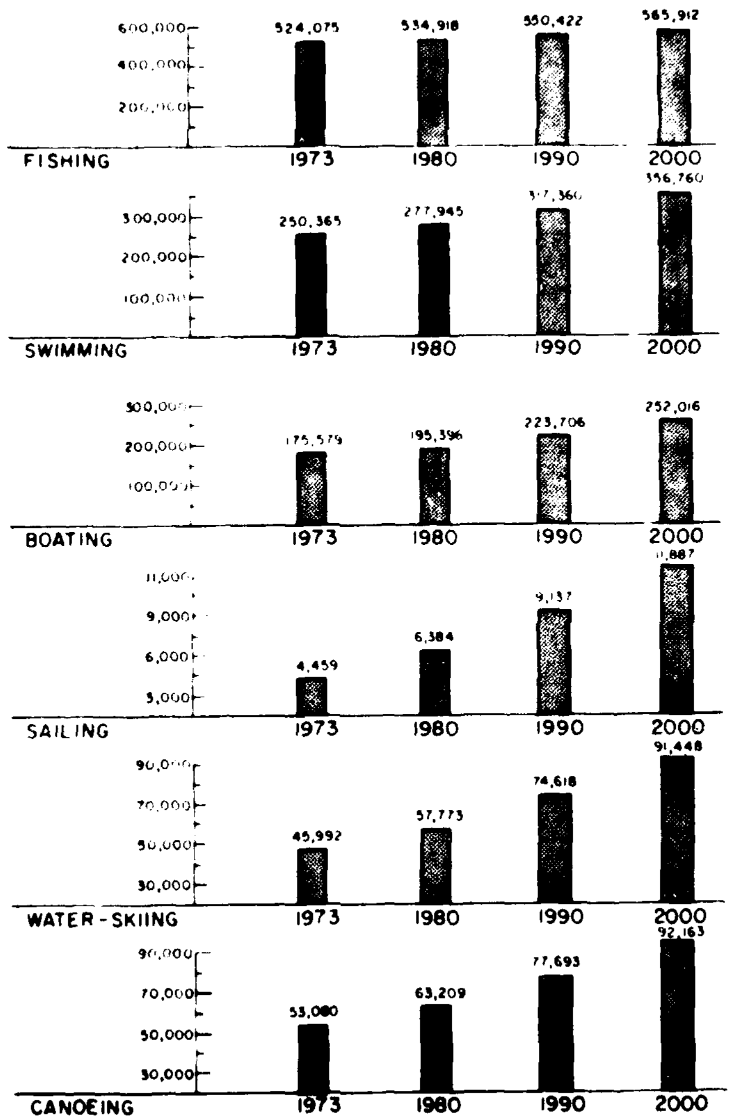


FIGURE 1b

ESTIMATED LAND-BASED RECREATION ACTIVITY DAYS FOR NORTH DAKOTA PLANNING REGIONS 3-6

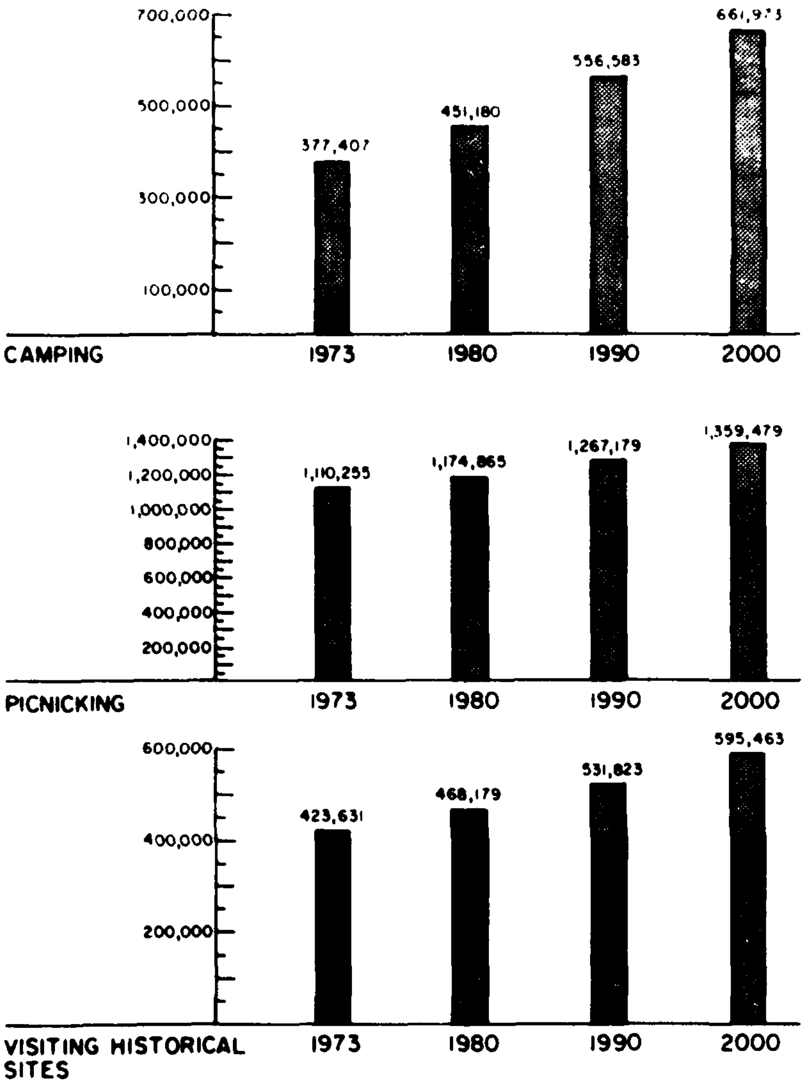


FIGURE 1c

ESTIMATED GAME RECREATION ACTIVITY DAYS FOR NORTH DAKOTA PLANNING REGIONS 3-6

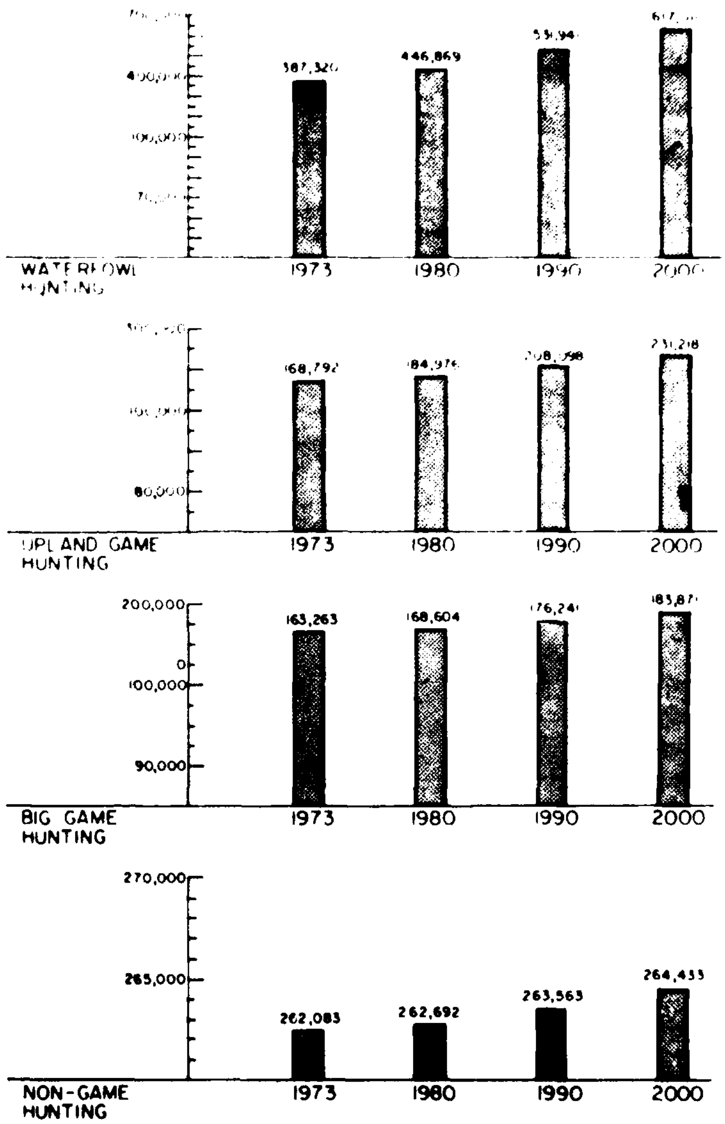
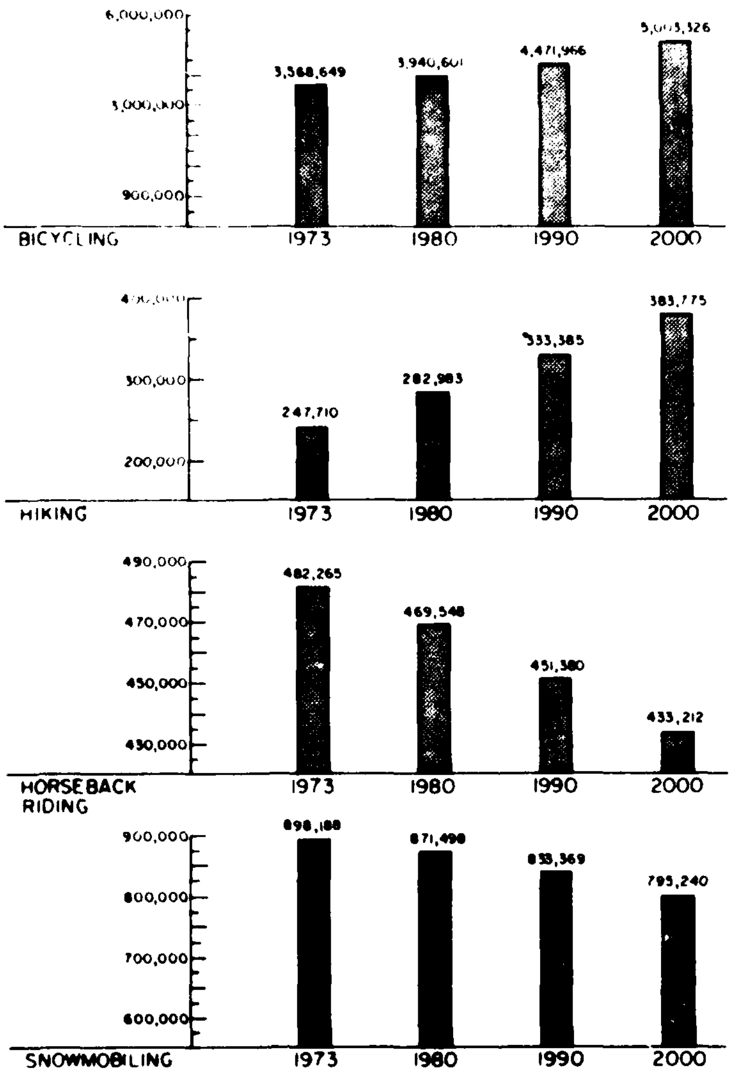


FIGURE 1d

ESTIMATED CORRIDOR RECREATION ACTIVITY DAYS FOR NORTH DAKOTA PLANNING REGIONS 3-6



Population

Fargo-Moorhead (approximate population - 100,000) is the major population center and recreation use generator in eastern North Dakota. Population is increasing rapidly along the Sheyenne River, both upstream and downstream of West Fargo. Population projections shown in this report reflect a near-doubling of population in the Fargo-Moorhead area over the next 50 years, while most rural county populations upstream of the lower valley area are generally expected to decline.

Because good water-based recreation opportunities within the region are scarce, most area recreationists travel considerable distances for desirable experiences. Fargo-Moorhead is located at the intersection of major highways (see figure 2). Residents traditionally travel to such areas as Detroit Lakes and Fergus Falls in Minnesota's western lake area, 50 miles east. Sixty miles west from Fargo-Moorhead on I-94, Lake Ashtabula provides opportunities for boating, fishing, and camping. Also to the west, the Missouri River valley has hundreds of miles of public shoreline. The Detroit Lakes area, 100 miles southeast in Minnesota via I-94, provides recreation opportunities similar to those at Lake Ashtabula. The largest man-made lake in the United States, Lake Sakakawea, is in the region. Lake Sakakawea, Lake Oahe, and other lakes and streams in western North Dakota are also now used by area residents. These include Lake Jim in Stutsman County and Devils Lake in Ramsey County, 90 and 60 miles northwest of Fargo, respectively.

Recreation Needs

The increasing urban population will generate substantial demand for outdoor recreation activities. The 1975 and 1980 North Dakota State Comprehensive Outdoor Recreation Plan (SCORP) and the North Dakota State Park System Plan indicate that boating and fishing are popular local interests but that most of this demand

is presently satisfied in regions outside the valley. Canoeing is an example of this relationship. Approximately 20 percent of the State's demand for canoeing activity originates in the four-county area adjacent to the lower Sheyenne, but except for minimal use on the Sheyenne, most canoeing is done elsewhere.

Figure 3 reflects regional demand-supply-need estimates taken from the appropriate State SCORP. These estimates show that boating, camping, picnicking, canoeing, and hiking require additional resources within most of the regions adjacent to the project area. For boating, access to existing resources and the creation of additional boating areas are needed. To meet present fishing demands, the SCORP's indicate the need for improvements in water quality of existing water resources, including the Sheyenne. Canoeing needs include access, preservation, and improvement of existing resources.

Existing Recreation Facilities

Major existing recreation resources within the valley are located along the river in a scenic 110-mile stretch from Kathryn to Kindred (see figure 2). These include Lake Ashtabula, Little Yellowstone, Clausen Springs, Kindred Mill Site, and several county parks. Lake Ashtabula is the major flatwater resource in the immediate area, consisting of 5,000 water acres and 3,500 adjacent land acres. Popular activities include boating, fishing, and camping. Figure 4 summarizes the number and type of existing facilities available at Ashtabula. A Corps master plan for Lake Ashtabula projects that use of this resource will increase about 15 percent by the year 2000, with annual visitation of between 540,000 to 560,000 people.

Lake Jim, 90 miles northwest of Fargo in Stutsman County, and Devils Lake, 60 miles northwest of Fargo in Ramsey County, also provide good quality water-oriented recreation opportunities.

POLITICAL BASE MAP

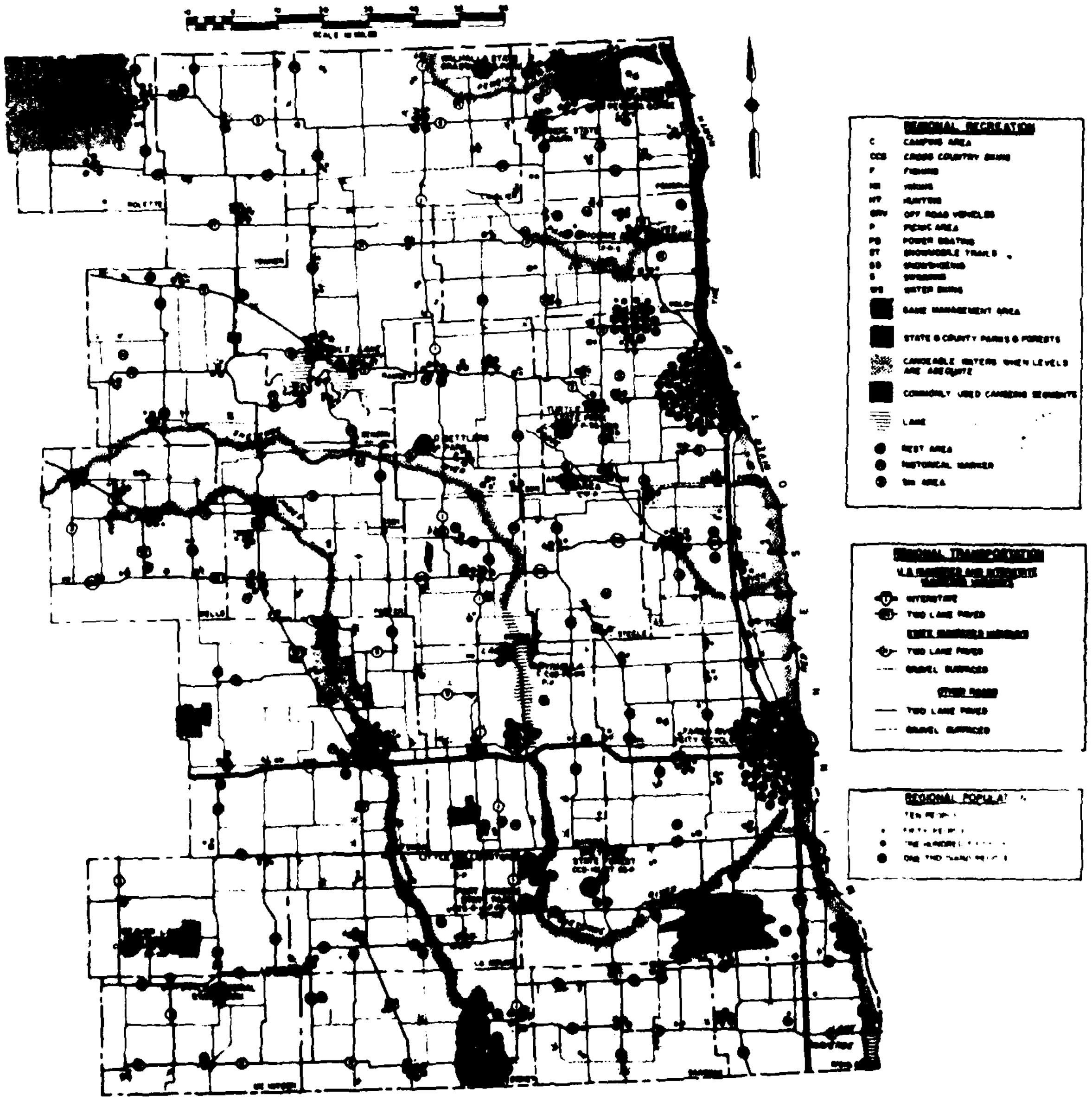


FIGURE 3

DEMAND-SUPPLY-NEED ESTIMATES - BY PLANNING REGIONS

Planning Region	Boating Water Acres					Fishing Water Acres					Camping (sites)					Picnicking (tables)					Water Skiing (acres)				
	Supply	Demand		Need		Supply	Demand		Need		Supply	Demand		Need		Supply	Demand		Need		Supply	Demand		Need	
		1980	1990	1980	1990		1980	1990	1980	1990		1980	1990	1980	1990		1980	1990	1980	1990		1980	1990	1980	1990
N. Dak. Region 3	11,366	6766	5505	none	none	13,102	6085	6262	none	none	434	610	750	105	190	318	803	846	485	528	11,366	2412	3115	none	none
Region 4	906	2603	3069	1697	2163	953	1605	1652	675	652	229	330	610	61	108	726	1463	1534	737	808	906	1447	1649	541	963
Region 5	1749	1861	2233	162	314	3313	2361	2608	none	none	203	405	497	121	.176	772	1778	1860	1006	1088	1749	1003	1298	none	none
Region 6	10,306	9006	10537	none	223	12,556	9697	9978	none	none	727	1232	1522	303	477	1071	1286	1368	215	297	10306	4342	5606	none	none
S. Dak. Region 4	34,879	24667	30467	none	none	no figures available					551	2058	2572	1507	2021	957	1852	2125	895	1168	no figures available				
Minn. Region 4	279,511	no figures available				202,856			none	none	3572	4712	6339	1140	2767	1784	2227	2437	443	653	no figures available				
Region 6	180,881	no figures available				66,242			none	none	936	1716	2149	778	1211	1056	1507	1636	451	582	no figures available				

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FIGURE 4

Existing Facilities – LAKE ASTHABULA

	MPUA	BALDHILL DAM	SUNDSTROMS LANDING	EGGERTS LANDING	KATIE OLSEN'S	EAST ASHTABULA	WEST ASHTABULA	OLD HIGHWAY 26	KEYES CROSSING	TOTAL
SWIMMING BEACH	1		1			1				3
BOAT LAUNCH (LN.)	1(2)		1(2)	1	1	1	1	1	1	8
PARKING	165	12	75	30	40	-120-		75	60	577
PLAYGROUND	X		X		X	X				4
PICNIC UNITS	65		16	14	12	75	32	10	4	228
FIREPLACES & GRILLS	31		10	8	8	47	26	5		135
FIREWOOD	X		X	X	X			X		
PICNIC SHELTER	X		X	X	X	X	X	X		7
CAMPING	27			23		51	9	20		130
POTABLE WATER	X	X	X	X	X	X	X	X		
FLUSH TOILETS	X	X								
VAULT TOILETS	X		X	X	X	X	X	X	X	
CONCESSIONS	X			X						
MAINTENANCE FACILITY		X								
RESIDENCE		X								
SEWAGE TREATMENT PLANT	X									
ACRES	70	5	9	28	11	12	23	27	2	187

Other regional resources along the Sheyenne include Sheyenne State Forest, the Sheyenne National Grasslands, and Fort Ransom State Park. The Sheyenne State Forest (613 acres) currently provides inland primitive camping and hiking opportunities. The U.S. Forest Service administers the 112,340 acres of the Sheyenne National Grasslands which currently service hunters, hikers, campers, horseback riders, and off-road vehicle (ORV) users such as snowmobilers. Fort Ransom State Park is a relatively new park which has historical and ecological significance. Use of the park has been limited because of its relatively small size and because construction is not yet complete. Also, the absence of a lake limits the type of activities available.

The Sheyenne River Valley receives its greatest recreational use from area hunters and trappers. Federal and State game managers claim the area has the best white-tailed deer habitat and population on a density-per-acre basis in the State. Twenty percent of the State's duck hunting user days are accounted for in valley counties, which provide a large portion of the State's annual duck production. Trapping activity is also popular, with red fox, coyote, and other furbearers readily found throughout most of the basin.

Fishing in the Sheyenne is generally limited to spring high water, and to such species as bass, catfish, and carp. The poor water quality of the river greatly limits sport fishing. Lake Ashtabula provides the best local fishing opportunity within the study area; perch, walleye, and northern pike are common species found there. Existing camping facilities in the basin are geared to tourists traveling through the area, and emphasize trailer camping. Lake Ashtabula, Little Yellowstone and Clausen Springs County Parks, and Fort Ransom State Park are major camping areas. The State's Travel Division, in conjunction with other agencies, promotes sightseeing along a scenic drive from Lisbon through Fort Ransom, Enderlin, and the Mirror Pools Game Management

area to Kindred. The drive attracts a moderate number of sightseers, and local interest has generated a proposal (Viking Scenic Highway) to provide road improvements adjacent to this route (see Exhibit I-A). No other developed sightseeing activities are known to exist in the study area.

Proposed Development: North Country Trail

> "It is proposed that the Congress authorize the establishment of the North Country Trail as a component of the National Trails System. This proposal is the result of a study conducted by the B.O.R. (HCRS) as directed by the National Trails System Act of 1968 (P.L. 90-543). This act directed that the North Country Trail from the Appalachian Trail in Vermont through the States of New York, Pennsylvania, Ohio, Michigan, Wisconsin, and Minnesota to the Lewis and Clark Trail in North Dakota (approximately 3,200 miles) be studied to determine the feasibility and desirability of designating it a National Trail."[1]

The 256 miles of the proposed trail within North Dakota would provide a linear trail system connecting some of the key recreation facilities mentioned above (i.e., the Sneyenne National Grasslands area, Fort Ransom area, Little Yellowstone County Park, and, to the north, the Devils Lake area) with adequate hiking and horseback riding trails. (See figures 5 and 6, general description of the trail within North Dakota.)

There are other proposals to enhance recreation in the Sheyenne basin. The U.S. Forest Service is preparing a management plan for the Sheyenne National Grasslands. Exhibit I-C summarizes the current status of this planning effort as it relates to recreation. The North Dakota Park Service is initiating a

[1] "The North Country Trail - A Potential Addition to the National Trails System." Final Environmental Impact Statement, Bureau of Outdoor Recreation, p. 1.

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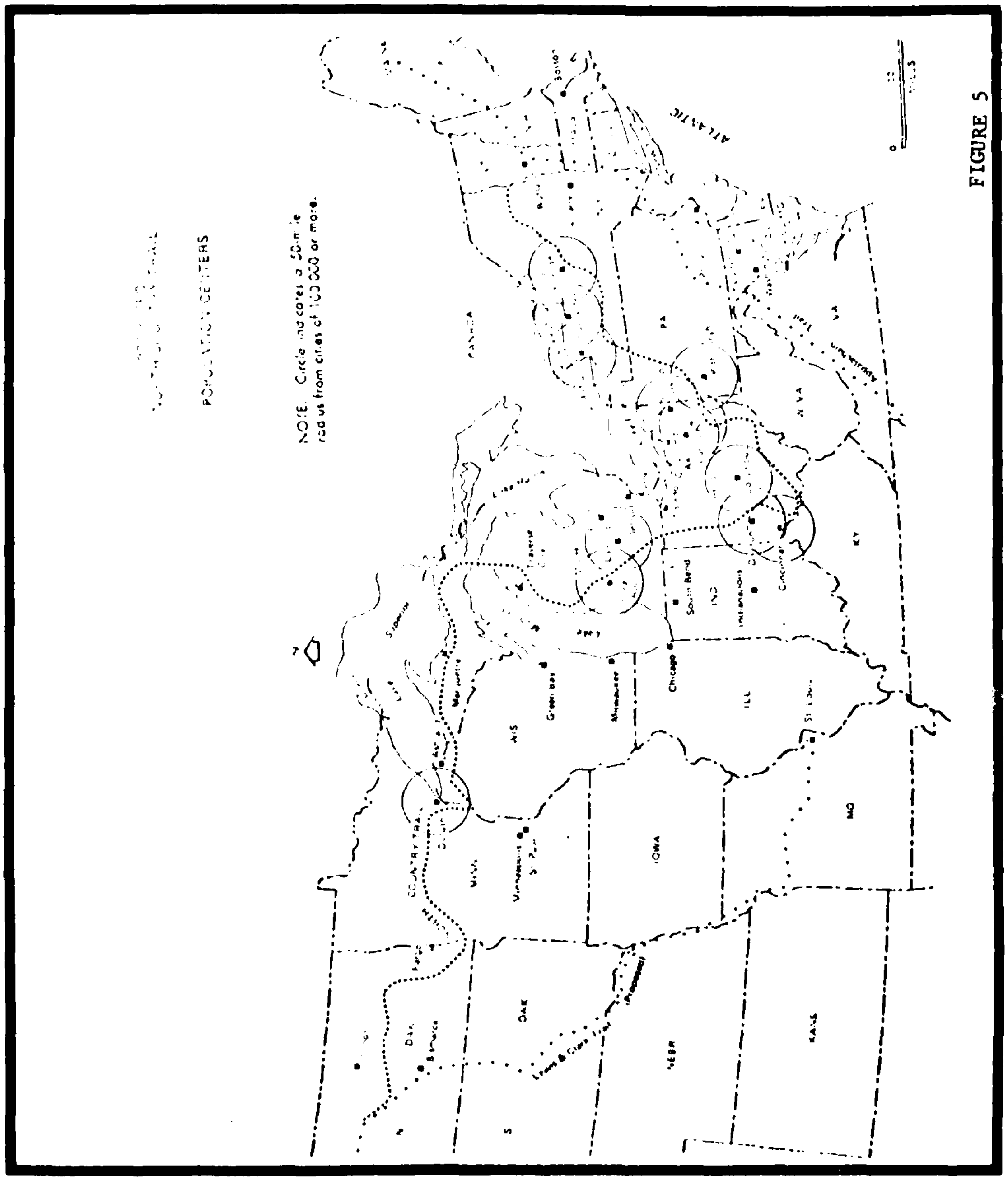
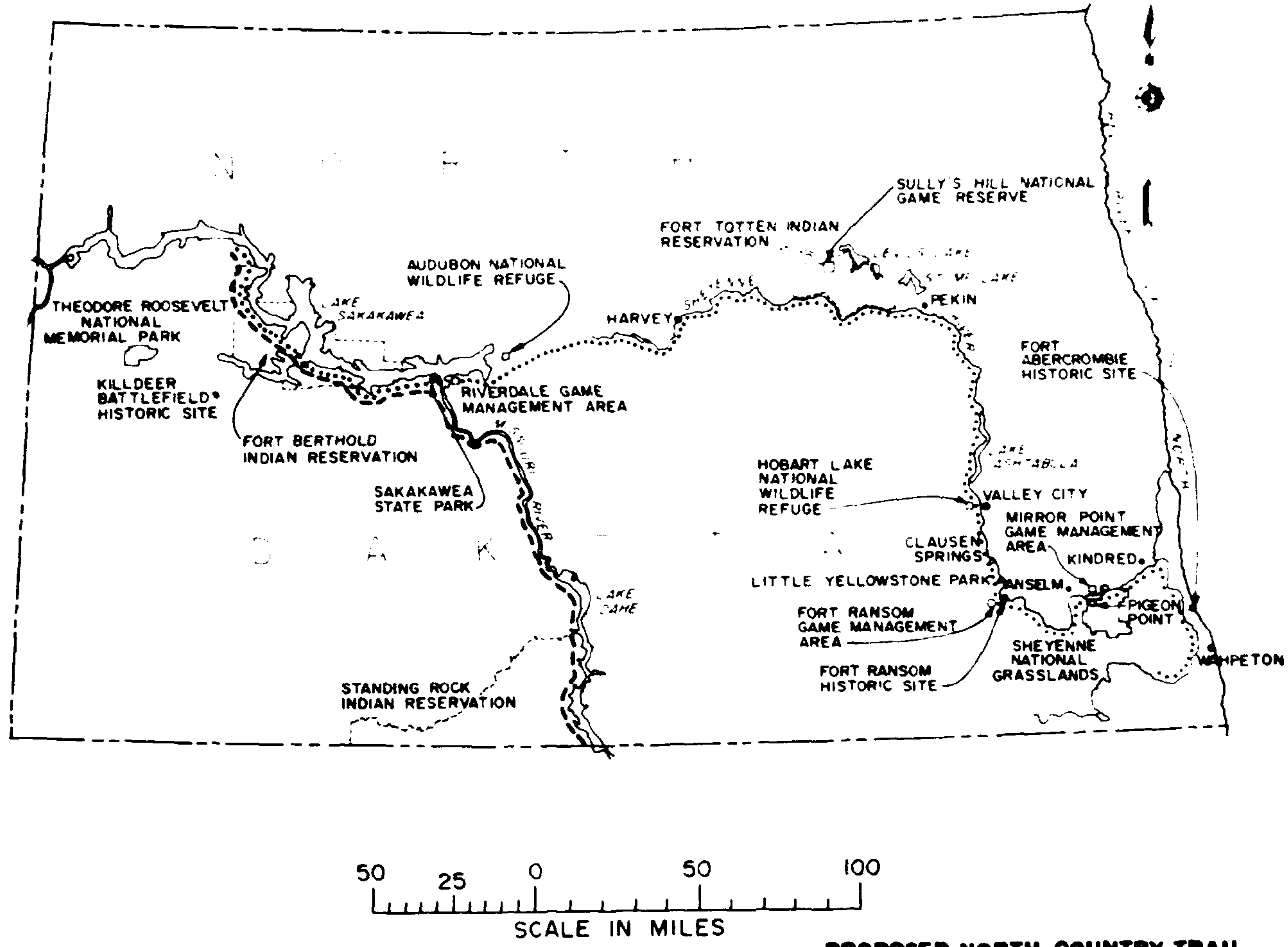


FIGURE 5



PROPOSED NORTH COUNTRY TRAIL

FIGURE 6

new SCORP that could have major future impacts on the provision of canoeing, camping, and related riverine facilities throughout the Sheyenne River valley.

As previously noted, the North Dakota Department of Parks and Recreation has designated a 110-mile section (Kathryn to Kindred) of the Sheyenne as a scenic canoeing river. Lack of public access, low summer flows, and river obstructions have greatly limited existing canoeing use (see Exhibit I-B). The State Legislature's previous interest in creating a State Wild and Scenic Rivers Program, which would include the Sheyenne River, has all but disappeared.

Future Development

> "In general, however, urban areas are experiencing considerably more stress with respect to facility demands. While on the other hand, rural areas within the region can expect to carry the burden of satisfying the urban residents demand for a variety of resource oriented activities.
>
> Because of the scarcity of resources for the support of resource and trail-oriented activities, the Sheyenne River Valley specifically is expected to carry the burden of increased user pressures. That area with its heavily forested hills and meandering rivers is an ideal location for hiking, cross-country skiing and canoeing, just to name a few activities."[1]

[1]"An Inventory and Guide to Outdoor Recreational Needs in the Lake Agassiz Region," the Lake Agassiz Regional Council, 1976, p.38.

Although many recreationists will still continue to travel to other areas within the State or to Minnesota, recent increases in energy costs will undoubtedly cause greater percentages of the increasing number of users to find their way to the Sheyenne River valley.

The above paragraphs summarize the short-term future of recreational use and development of the Sheyenne River valley. A basic assumption in recreation planning is that people will travel the shortest distance necessary to obtain the quality recreation experiences they desire. Again, based on the current energy situation, when quality recreation opportunities are developed within the Sheyenne River valley, they will draw recreationists currently using similar resources farther away and will attract new recreationists interested in the unique experiences that these opportunities will provide.

Although a comprehensive recreation master plan for the study area is widely acknowledged by resource planning agencies as a priority need, no efforts have been made to provide such a plan. Without a guiding plan to ensure cooperative planning for recreation resource development between Federal, State, regional, and local agencies and institutions, it can only be hoped that informed cooperation will ensure the provision of quality outdoor recreation opportunities while protecting the environmental integrity of the area.

From the review of proposed actions noted in the previous sections, it seems likely that new recreation developments wil' be slowly introduced into the valley, mostly through Federal and State involvement. Along the river, facilities being considered for Fort Ransom State Park would increase the existing recreation use, which is now centered on the historical attractions of the area. If Sheyenne River obstructions to canoeists are cleared and riverside campsites and related facilities within the National Grasslands area are approved, these improvements together with the Sheyenne State Forest

facilities would eventually increase overall river use. As this use continues to grow, the demand for a linear trail system (i.e., hiking, snowmobiling, canoeing, horseback riding, bicycling) linking these modes of recreation activity would also increase. This demand may be eventually satisfied to some degree by the implementation of the North Country Trail.

In contrast to these proposals, no major efforts are currently being made to improve the poor water quality of the Sheyenne. Without such an effort, the fishing and swimming values of this resource will probably remain low.

An optimistic assumption is that the proposed developments noted here will increase public use of the river and its associated resources within the valley. As public awareness continues to expand, so will public pressure on the State legislature to provide increased protection for this valuable resource.

Because of the generally depressed, agriculturally-based economy of many of the rural communities within the study area, there is a strong dependence on use of Federal Land and Water Conservation (LAWCON) funds for project costs. Within the lower Sheyenne River Valley, 29 existing projects and 5 proposed developments are scheduled for Federal assistance (see figures 7 and 8). The developments would include land acquisition, pools, golf courses, campgrounds, tennis courts, and the expansion of existing parks and playgrounds and would be located mostly within such urban communities as Fargo, West Fargo, Valley City, Lisbon, and Kindred. The total dollar investment for both existing and proposed projects is approximately $5 million. Although recent executive and congressional cuts of LAWCON funding may make it extremely difficult to obtain this funding, the size of the investment does reflect the growing concern on the part of area officials to close the large gap between local demands for outdoor recreation opportunities and the low quality and

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FIGURE 7

EXISTING LAND AND WATER CONSERVATION FUND PROJECTS
IN THE LOWER SHEYENNE RIVER VALLEY

Project Location	Description	Fed. Share	Cost Total
Clausen Springs	- 335 acres of land acquisition	$19,000	$ 38,000
	- Recreation complex	70,000	140,000
Clausen Springs & Little Yellowstone Park	- Park improvements	3,750	7,500
Fargo	- Model cities; playground equipment, tot lots, swimming pool	43,000	86,000
	- Lindenwood Park Camping Center	12,000	24,000
	- Riverfront Development #1; golf course, tennis courts, Senior Citizens Park, other various projects	295,000	590,000
	- Riverfront Development #2; fencing, comfort station, tennis/basketball courts	222,000	444,000
	- Multi-purpose park; golf course	355,000	710,000
	- Island Park Pool (Committed)	177,000	1,100,000
	- Southwest Park acquisition	9,500	19,000
	- Southwest Park development	125,000	250,000
Fort Ransom	- Land acquisition	3,750	7,500
	- Campground	94,800	316,000
Kindred	- Swimming pool	23,500	47,000
	- Pool addition	2,000	4,000

FIGURE 7
(CONT)

Project Location	Description	Cost: Fed. Share	Cost: Total
Lisbon	- Tennis courts	$ 5,[illegible]00	10,000
	- Campground	3,750	7,500
	- Playground equipment	1,000	2,000
Riverside	- City park	1,625	3,250
West Fargo	- Tennis courts	10,500	21,000
	- Acquisition of 6.75 acres of land	8,500	17,000
	- Park development	16,000	32,000
	- Hockey rink	6,250	12,500
	- Swimming pool	350,000	700,000
	- Acquisition of 40 acres of land	30,000	60,000
Valley City	- Park development	11,250	22,500
	- Park facility improvements and additions	12,000	24,000
	- Pool heater	9,000	18,000
	- Parks improvements	8,500	17,000

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FIGURE 8

PROPOSED LAND AND WATER CONSERVATION FUND PROJECTS
IN THE LOWER SHEYENNE RIVER VALLEY

Project Location	Description	Total Cost
Clausen Springs	Park Improvements	$ 10,000.00
Fargo	Tennis Court Lighting	48,000.00
Lisbon	Tennis Courts	27,000.00
West Fargo	Bonanzaville Campsite	120,000.00
Valley City	Tennis Courts	32,000.00

quantity of existing resources.

LOCAL EXPRESSION OF NEED

Based on information obtained from public workshops and local surveys, there is a need for additional water-oriented recreation developments. Public input concerning local recreation needs has been limited, but the following data provide some indication as to their priority. The following list of recreation needs ranked by priority was obtained from a public workshop held in Fargo, North Dakota, in June 1977.

High Priority Needs

Determine economic value of recreation to area.

Maintain unique areas.

Improve trapping.

Medium Ranked Priority Needs

Provide land-based recreation in Sandhill area.

Preserve scenic values of Sheyenne basin.

Develop suitable areas for off-road recreation vehicles in Sandhill area.

Remove obstructions in Sheyenne River which prevent canoeing.

Develop hiking trails.

Provide better recreational planning within study area.

Improve hunting.

Improve fishing.

Low Ranked Needs

Develop water-based recreation in Sheyenne basin.

Public acquisition and preservation of selected lands for recreational use.

Improve sign system indicating location of public areas.

Provide more camping facilities.

Develop Fort Ransom Park.

Determine possible effect of proposed North Country Trail.

Additional public input was obtained from surveys conducted by North Dakota State University (NDSU) as part of a series of studies dealing with land use and water quality within the lower Sheyenne River valley.

Responses to a questionnaire circulated to all levels of governmental decision makers witn jurisdiction in the study area indicated that, in ranking various uses of the Sheyenne in order of importance, fish and wildlife habitat and water sports and recreation ranked high for all respondents.

> "The number of different leisure-time activities pursued by respondents in or near tne basin was related to tneir location of resident. There was little use of the river involving bodily contact with the water, such as swimming or water skiing. Most of the recreational activity involved the river indirectly - hunting, camping, snowmobiling, picnicking, and hiking...Fishing, a direct use of the river, was a popular pastime among local respondents."[1]

An additional NDSU survey of the same group was directed toward determining environmental trade-offs in the lower Sheyenne valley.

> "Respondents were willing to give up, or trade off, some scenic view and some land recreation potential (with the exception of respon-

[1] "A Profile of Public Officials, Government Structure, and Environmental Issues in the Lower Sheyenne River Basin, N.D." by Leitch, Nelson, and Saxowsky, North Dakota State University, Sept. 1977, p. 26.

dents living near the proposed Kindred reservoir area) in order to decrease the chances of flooding and increase water recreation activity ... Although the level of wildlife habitat was high to begin with, there was no desire expressed to either increase it or to sacrifice it for higher levels of the other environmental variables. The variables, scenic river and land recreation, appeared to be valued less than wildlife habitat, since they were traded off more readily."[1]

Residents are concerned about opportunities for hunting and trapping. Other popular activities including fishing, hiking, off-road vehicle use, and camping were all noted as medium ranked activities. It may be concluded that local decision makers are interested in expanding the opportunities for various outdoor recreation pursuits but not at the expense of existing scenic values and wildlife habitat within the study area.

OPPORTUNITIES TO MEET RECREATION NEEDS

Proposals for the expansion of recreation opportunities discussed earlier will meet some of the land-based recreation needs of the area. The State's new SCORP will assist in securing Federal funding to support local urban recreation projects and will help ensure new leisure-time opportunities. County and local government commitment is also reflected in the previously noted schedule of projects proposed for receipt of LAWCON dollars.

Federal and State Government agencies are involved in the operation and maintenance of management areas established for the production and protection of a variety of wildlife species. Within the four adjacent counties along the southern end of the river basin, the U.S. Fish and Wildlife Service manages over 15,000 acres for waterfowl production and

[1] Ibid. p. 21

over 4,000 acres within four wildlife refuges. The North Dakota Game and Fish Department administers approximately 9,000 acres for these purposes as well. The degree of productivity of these areas varies with availability of financial resources to support management efforts. For example, the 500-acre Mirror Pools Game Management area has been minimally developed, but with its uncommon spring-fed streams and pools, it has potential as a major productive cold water hatchery. Both Federal and State Wildlife agencies have slowed current land acquisition programs because of local opposition throughout most of the State.

Important resource concerns not addressed by current agency programs include:

Comprehensive recreation planning.

Protection of scenic values.

Improvement of water quality.

Linear trail development.

Provision of off-road vehicle use areas.

Improvements for river canoeing.

The following measures were identified through coordination with local, State, and Federal agency representatives and public workshops. They are presented as alternative management directions which address study area priorities for recreation resource development.

Federal Involvement

Appropriate Federal agencies of the Department of the Interior are encouraged to continue financial service to the State in its programming of land and water conservation funds to support cost sharing of recreation resource developments within the study area.

Federal support is encouraged to obtain congressional action for implementation of the North Country Trail Plan. Final planning stages should look carefully at proposed economic and environmental impacts of the trail, which are of considerable concern to some study area interest groups.

The U.S. Forest Service has already indicated interest in coordinating its master planning efforts for the Sheyenne National Grasslands with other Federal and State interests. This unique area has the potential to provide a variety of low-intensity recreation uses, including horseback riding, hiking, wildlife observation, and ORV use while still preserving its natural attributes. The Forest Service should consider the use of lands adjacent to the Sheyenne River for trail and primitive campground development. This area could serve as an essential link to other potential river corridor recreation centers such as Fort Ransom State Park and Sheyenne Forest.

The U.S. Fish and Wildlife Service is encouraged to continue working with State Game and Fish personnel in the management of area resources for the production and protection of wildlife. There appears to be a need for coordinated, comprehensive plans identifying regional objectives for wildlife management. This would require detailed inventory surveys and an aggressive public involvement program for area hunters and trappers, who make extensive use of valley resources.

Structural flood protection alternatives as proposed within this study generally fall within two categories: a flatwater storage reservoir or a program of urban levees and diversion channels. The St. Paul District, Corps of Engineers, with cooperation from a local cost-sharing sponsor can provide recreation resource developments in conjunction with its flood control measures. Recreation trail-park development along and adjacent to levees would meet some of the needs identified within this report and would be compatible with the river recreation corridor concept noted earlier. The recreation potential of a reservoir includes activities such as swim-

ming, boating, fishing, sightseeing, camping and picnicking. There would be trade-offs involved with this measure, such as the loss of existing hunting, trapping, and river canoeing opportunities.

State Involvement

The revised North Dakota SCORP, now being developed by the State Park Service, should provide guidance to Federal, State, and local units of government. An issue of public concern is the establishment of a State Wild and Scenic Rivers Program which could be designed similar to the Federal program. Such a program could provide legislative protection for the scenic, recreational, and environmental resources of the Sheyenne which are under constant pressure from agricultural and urban housing interests.

The State could ease the financial burdens of local government by implementing a program similar to those of Minnesota, Wisconsin, and Michigan, which can provide financial assistance on a cost-sharing basis in conjunction with LAWCON funding. State assistance for operation and maintenance costs should also be considered.

The following management related items are briefly listed for State consideration:

1. Continue work on master plan for Fort Ransom State Park to include sports facilities for river users.

2. Initiate action on a Nature Preserve Program to protect proposed recreation sites within the study area.

3. Seek congressional support for North Country Trail Plan and implement segments along the Sheyenne River to link key recreation areas.

4. Support efforts to improve conditions for scenic roadways within the valley (e.g., Viking Trail).

5. Develop fish and wildlife potentials of the Mirror Pools Game Management area.

6. Develop primitive campsites and related facilities for river users

within the Sheyenne State Forest area.

7. Under the guidance of area wildlife biologists establish a program with Federal and local assistance to clear river obstructions (snags) to canoeists along the Sheyenne.

8. Develop a cultural resources management plan to identify the historical linkage of known sites and to provide opportunities for historical trails, interpretive attractions, etc.

9. Conduct a study of outdoor recreation vehicle use (e.g., snowmobiles, trail bikes, all-terrain vehicles within the Valley-Sandhill area to determine appropriate location for their use.

Local Government Involvement

The Sheyenne River serves as a recreation resource attraction for the urban communities along its banks. County and local governments are encouraged to continue their efforts to improve existing areas and to develop new access areas, riverside parks, trails, etc., to ensure public opportunities to use and appreciate the river and to develop increased public support for the protection and enhancement of its environmental qualities.

A major problem requiring the cooperative efforts of all levels of government is the improvement of water quality in the Sheyenne. Solving problems such as garbage dumping, raw sewage emissions, low flows, drainage ditch flow, fertilizer runoff, and livestock residuals will require a cooperative and comprehensive program to obtain the support of riparian landowners.

PLAN FORMULATION RATIONALE

The following list of recreation resource management objectives reflects the highest priority concerns within the study area for the provision of quality outdoor recreation. The formulation of future plans which will have

impacts on the valley area should be weighed against these objectives to determine both positive and negative effects of these plans.

1. Protection and enhancement of the scenic values of the river and adjacent valley resources.

2. Protection and enhancement of fish and wildlife habitat within the area to provide increased opportunities for hunting and trapping.

3. Improvement of water quality.

4. Provision of improved public access to the river, combined with a corridor of public use areas linked by alternative forms of travel throughout the scenic areas of the river. Emphasis should be placed on improvements near urban centers.

5. Implementation of a master plan for recreation resource management and public use development for the study region which will address the concerns identified above and provide a blueprint for future direction of proposed government and private actions.

SUMMARY

The valley corridor provides an environment in which diverse recreation opportunities could be established. Existing and potential recreation resources provide an excellent opportunity for development of a recreation/environmental corridor composed of centers of activity linked by various trail systems (incorporating the North Country Trail). These might include resources provided within urban areas (riverside parks, campgrounds); Federal, State, and county areas (Sheyenne National Grasslands, Fort Ransom State Park, Little Yellowstone, etc.); recreation facilities constructed as part of flood control improvements; and smaller activity centers such as fishing access points and hunting camps.

High priority outdoor recreation needs within the study area have been expressed. The extent and type of government involvement were identified in coordination with area agency representatives and in public workshops

which provided input into recreation resource development. Local residents are interested in expanding the amount of recreational opportunities within the study area but are not willing to sacrifice existing scenic values and wildlife habitats in exchange.

With urban populations growing, public pressure for outdoor recreation opportunities will increase. Recreationists will use those resources closest to them, given quality equal to competing areas. The Sheyenne valley area will receive light-to-medium public use once new opportunities are provided. The formulation of future plans affecting the valley area should be assessed with respect to the protection of scenic values of the valley area and proposed recreation opportunity enhancement.

PERTINENT AUTHORITIES FOR IMPLEMENTATION

The following is a general discussion of existing recreation and fish and wildlife enhancement authorities pertinent to Corps activities.

I. Basis for Corps Participation in Recreation Development

A. Section 4 of the Flood Control Act of 1944. This act authorized the Chief of Engineers "...to construct, maintain, and operate public park and recreational facilities in reservoir areas under the control of the (Secretary of the Army), and to permit the construction, maintenance, and operation of such facilities." In 1959 and again in 1962 the Chief of Engineers issued instructions on inclusion of recreation development at reservoirs as a project purpose under specific limitation. The Flood Control Act of 1962 broadened the 1944 authority to include all water resource projects.

B. The Federal Water Project Recreation Act of 1965 (P.L. 89-72). This act established development of the recreational potential at Federal water resource projects as a full project purpose.

- Section 2(a) specifies that benefits for recreation should be included in the economics of a contemplated project, provided that non-Federal public entities agree (letter of intent) to participate in the recreation development. All purposes share in the savings from multiple-purpose development.

- Section 3(b) authorizes land acquisition to preserve the recreation potential of the project for a 10-year period, when no local sponsor can be found.

- Section 9 limits cost allocations to recreation and fish and wildlife enhancement (excepting special types) to no more than 50 percent of the sum of the allocations to all project purposes.

- The act further requires beneficiaries to bear part of the costs of installing and all the cost for managing recreation developments at Federal water resource projects. It also sanctions collection of user fees for services by non-Federal agencies administering the recreation resources of Federal projects.

C. Development of Outdoor Recreation Facilities. Outdoor recreation facilities are provided at Corps reservoir projects and at certain nonreservoir projects subject to requirements of local cooperation. In formulating recreation plans, consideration is given to alternative scales of project development ranging from the minimum facilities to optimum development. In the absence of satisfactory local agreement, Federal provision of facilities at reservoirs is limited to the minimum needed for public health and safety. Generally, this does not exceed provision of a turnaround, guardrails, barriers, and minimum sanitary facilities at existing road ends. No facilities are provided at nonreservoir projects in the absence of local participation. Recommendations for recreational development will not exceed the scale for which a qualified sponsor will furnish a written letter of intent to participate.

Pertinent existing authorizations applicable to specific recreation developments for each of the various flood control measures follow:

FLOOD CONTROL MEASURES	Authorizations: Fish & Wildlife Mitigation	Corps Recreation Cost-Shared*	Non-federal Entities	Other Federal Agencies (LAWCON)*	Corps O&M Programs*
Levee & Diversion @ West Fargo		X	X	X	
Floodway/Diversion-Horace to West Fargo		X	X	X	
Change Operation at Baldhill Dam					X
Dead Colt Creek Dam		X	X	X	
Wetlands	X	X			
Farm Ring Levees			X		
Small Pool Behind Kindred Dam	X	X	X		
Relocations at Valley City and Lisbon		X			

X = likely sponsor/s

X = possible sponsor/s

* Funds for actual implementation must be approved by Congress and the Executive Office.

II. Basis for Corps Participation in Developments for Fish and Wildlife

A. Fish and Wildlife Coordination Act of 1958 (P.L. 624-85). This act amended the act of 10 March 1934 to provide that fish and wildlife conservation shall receive equal consideration with other project purposes and be coordinated with other features of water resource development programs. Adverse effects on fish and wildlife resources and opportunities for fish and wildlife enhancement shall be examined along with other purposes.

B. Enhancement. Improvements for fish and wildlife enhancement shall be included in a project when the expected benefits, monetary or nonmonitary, exceed the cost of bringing them into existence and cannot be provided economically by other means. Acquisition of land for enhancement of the fish and wildlife resources requires specific legislative authorization.

C. Cost Sharing. Unless it is part of an authorized Federal program for enhancement of anadromous fish, separable first costs for enhancement of sport fish, wildlife, and wildlife resources are cost-shared on a 75 percent-25 percent basis with non-Federal interests, who assume all costs for operation, maintenance and replacements as set forth in P.L. 89-72. The terms "wildlife" and "wildlife resources" include birds, fishes, mammals, and all other classes of wild animals and all types of aquatic and land vegetation upon which wildlife is dependent. The requirement for sharing separable first costs of recreation development is 50-percent Federal and 50-percent non-Federal. Only the separable first costs of land acquisition and associated developments to enhance the production of sport fish and wildlife resources will be shared 75-percent Federal and 25-percent non-Federal. The separable first costs of

land acquisition to provide public access, and developments to promote the utilization or exploitation of wildlife resources, are expenditures made in the interest of enhancing opportunities for public outdoor recreation and as such will be shared 50-percent Federal and 50-percent non-Federal.

III. Mitigation Authorization

Mitigation of Damage. Measures to offset damages to fish and wildlife or recreational developments will be included in projects when the cost of such measures for this purpose can be justified. Acquisition of land for mitigation of damages to fish and wildlife or recreation resources requires specific legislative authorization.

SCOPE OF DEVELOPMENT PROPOSALS

Because of ongoing uncertainties regarding specific effectiveness of flood control measures and their implementability, selection of meaningful alternative plans and the recommended plan has been and will continue to be dynamic. Because of this and because the Corps can implement recreation and fish and wildlife measures only on the plan authorized by Congress, detailed recreation and enhancement planning is not appropriate at this time. Therefore, the scope of recreation plans presented in this analysis is conceptual in nature and considered optimal in facility size. Future detailed recreation planning on the selected plan of development will be coordinated with potential non-Federal sponsors.

POTENTIAL RECREATION ASSOCIATED WITH ALTERNATIVE PLANS

The following eight distinctly separate flood control measures have been identified in the main report as warranting further consideration. These measures in various combinations make up the selected plan and accompanying alternative plans.

(1) Levee and Diversion at West Fargo/Riverside

(2) Floodway/Diversion - Horace to West Fargo

(3) Change of Operation at Baldhill Dam (i.e., pool raise)

(4) Dead Colt Creek Tributary Dam

(5) Wetlands Development

(6) Farm Ring Levees

(7) Small Permanent Pool behind Kindred Dam

(8) Relocations at Valley City & Lisbon

A recreation potentials evaluation for each of these flood control measures follows. The need for recreation facilities, the specific authorities which allow Corps involvement, and the optimal conceptual plan with projected costs/benefits are analyzed

LEVEE AND DIVISION AT WEST FARGO/RIVERSIDE

The nature of urban levee and diversion measures limits the type of public recreation developments which are feasible. Linear trail corridors are best suited, and many alternatives are available for recreational trail development associated with this flood control measure, as outlined below:

(1) The SCORP shows State and regional priorities and needs for trail facilities in the project area. Bicycling is the most popular activity in Region V, with more than double the participation of any other activity, and it is projected to increase substantially in the future. Since local plans for

a metropolitan bikeway show a future trail along the alignment of the proposed levee and diversion, local sponsorship is likely.

(2) The proposed North Country Trail System would pass through the project area and a trailway along the levees could be incorporated as a part of this regional system.

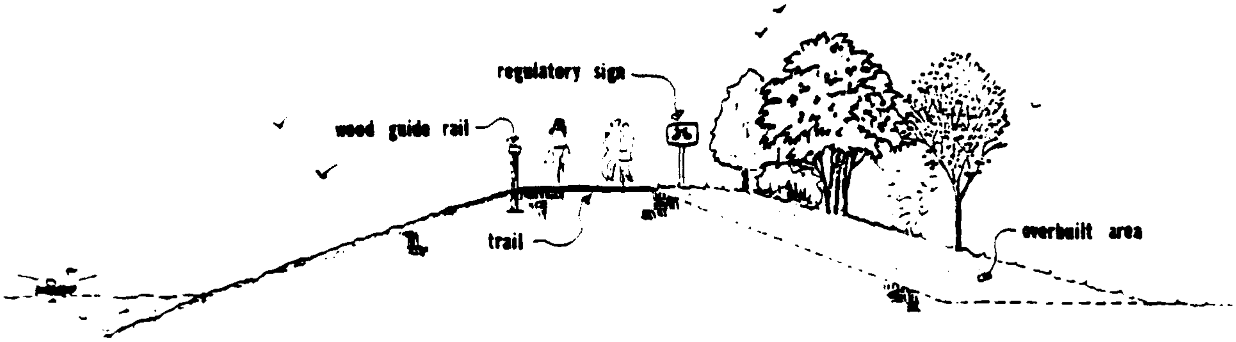
(3) Trail activity participation has increased dramatically and projections show this trend will continue. Urban trails play a particularly important role in satisfying this demand.

(4) Development of the floodway/diversion - Horace to West Fargo creates possible links to a network of trailways (assuming potentials associated with that measure are realized).

(5) From a local perspective, the changes in grade caused by the levee system would provide a desirable variation to the landscape, and the continuous strip of easements/government-owned lands along the river would facilitate development of a trail system for such uses as bicycling, pleasure walking, jogging, nordic skiing, and sledding.

Furthermore, if landscape plantings and other beautification measures were incorporated into the design of these trails, the recreational and visual experience offered by the area would be enhanced (see figure 9 for typical landscape treatment). With a top width of 10-12 feet and a length of almost 10 miles, the levee system could also provide significant nonvehicular transportation opportunities.

The eastern half of the levee system could be used as a park corridor to connect two existing riverfront (Sheyenne) city parks located only 1 mile apart. They cannot now be reached along the river because of the privately-owned property along the riverfront between the two parks. The western half of the levee system extends past the fairgrounds and into the west-side industrial areas and stockyards. Adjacent to the fairgrounds is the "Bonanzaville" tourist



CONCEPTUAL LEVEE CROSS SECTION
no scale

FIGURE 9

attraction, which draws many visitors from the Fargo-Moorhead metropolitan area. The western half of the levee system, when linked with existing east-west bikeways, could extend from the metropolitan area through West Fargo, and could provide a link westward to Bonanzaville and the fairgrounds.

If this flood control measure is authorized for construction, Corps cost-sharing authorities (Public Law 89-72) would allow the Corps to fund 50 percent of recreational trail development costs (see previous Authorities Section for details). Ideally the recreational trails should be located on top of each levee along both sides of the diversion. Each trail should be developed separately and for different mixes of activities which might conflict if combined (e.g., bicycling and walking may not be a compatible mix). Considerable coordination with local parks representatives and the public must be undertaken to identify the trail uses which should be accommodated and/or excluded. An appropriate trail surface and support facilities should then be provided to service those needs, giving consideration to user requirements and operations and maintenance trade-offs involved.

Typically, constructing a hard-surfaced trail 8-10' wide which is suitable for a bikeway costs from $15,000 to $45,000 per mile (depending on associated amenities such as landscaping and lights, support facilities provided, and quality of construction). Gravel or dirt trailways would be acceptable for certain types of trail activities such as hiking or Nordic skiing. Costs associated with this type of trail usually range from $3,500 to $15,000 depending on support facilities and associated amenities provided, as noted above.

If demand is high for trail facility development, as it appears to be in the project area, the benefit-cost ratio for the trailway development will almost always be above unity (1.0). Benefits will usually exceed costs by ratios of 1.3 to 4.0, depending upon the scale of development and the effectiveness of management of the facilities.

FLOODWAY/DIVERSION - HORACE TO WEST FARGO

Rural floodway/diversion flood control measures offer limited opportunities for development of public trailways and/or hunting areas. These recreation uses can be conflicting if practiced intensively. However, trailway development appears to have the most potential for recreational benefits for the following reasons:

(1) Plans such as the State Comprehensive Outdoor Recreation Plan (SCORP) show State and regional priorities and needs for trail facilities in the project area.

(2) The proposed North Country Trail, a regional trail system, would be located just south of the project area, and a link to that trail system seems practical (i.e., trail development in the project area could form a finger off the North Country Trail).

(3) The project alignment is surrounded by crop and grasslands and is not adjacent to valuable hunting areas such as the Sheyenne National Grassland. There is minimal habitat to support intense hunting, and hunters will therefore seek out more productive habitat areas.

(4) The potential exists to connect or link a trail into the trailway proposed along the levee and diversion at West Fargo. This would result in a longer and potentially more attractive corridor trailway.

The fact that trail development associated with this flood control measure would be rural and that many people would feel this alignment lacks aesthetic values (i.e., straight-line channel through croplands) does diminish the potential for recreation benefits. Therefore, optimal recreation development associated with this flood control measure would require a scaled-down trail development; i.e., the low intensity use anticipated could not justify the cost of intensive development. A 6-foot wide gravel pathway appears to be the most feasible

solution, and would adequately service the needs of trail users such as hikers, bicyclists, and cross-country skiers. Typically, construction of a 6-foot wide crushed rock (gravel) trailway would cost $5,000 to $12,000 per linear mile. Careful evaluation of the costs and benefits associated with recreation development will be needed in future detailed studies because the economic feasibility of recreation benefits associated with this type of development is often marginal.

FLOOD POOL RAISES AT LAKE ASHTABULA

Project Location

Lake Ashtabula is located on the Sheyenne River in east-central North Dakota (see Location Map for Alternatives, Plan Formulation Appendix). The lake is a multipurpose project, operated to provide flood control, water supply, and recreational opportunities. Its primary function is control of the heavy spring runoff from snowmelt in order to reduce flood damages downstream of the dam.

At Baldhill Dam, all of the developed public use areas and the bulk of the lake's surface water lie in Barnes County. The upper portions of Lake Ashtabula and related Federal lands are located in portions of Griggs and Steele Counties. By highway, the dam is about 75 miles west of Fargo and about 12 miles northwest of Valley City, the Barnes County seat.

Project Lands

The total Lake Ashtabula project area comprises 8,483 acres. Federally-owned lands adjacent to the pool area, designated at 1266.0 feet above msl, consist of 2,386 acres. At normal operating level, pool length is about 27 miles, maximum width is 0.6 mile, and the surface area is 5,430 acres.

Lake Ashtabula is located entirely on Federally-owned lands and is surrounded by a narrow band of Federal land which in certain areas is reduced to only a few feet. At points along the lakeshore, however, these Federal lands are sufficient to provide room for recreational facilities. It is within these larger tracts that the existing recreational development has taken place. Present facilities include the Main Public Use

Area, Baldhill Dam Area, Sundstrom's Landing, Eggert's Landing, Katie Olson's Landing, East Ashtabula Crossing, West Ashtabula Crossing, Old Highway 26 Area, and Keyes Crossing, all of which are maintained by the Corps of Engineers (see figure 10).

Recreational activities provided at these areas include but are not limited to picnicking, camping, fishing, boating, beach swimming, hiking, waterfowl hunting, ice fishing, and snowmobiling. Major developments which provide recreation opportunities include boat launches, swimming beaches, picnic areas, campsites, concession stands, beach change houses, and parking facilities.

In addition, a number of users live year-round along the lake or own or rent summer cottages along the lake. These people may not use the public recreation facilities, but nevertheless use the lake for recreation.

Reservoir Operation

Each year, flood-control storage is made available in the lake by releasing the stored water after 1 October to ensure a drawdown to at least elevation 1262.5 by 1 March. Drawdown below that elevation is necessitated by forecasts of larger than normal spring runoff, heavier than normal snow, downstream water supply conditions, or other pertinent factors.

Zones of Influence

Observations by the area manager, park manager, and park rangers indicated that there are two zones of influence. The primary zone from which approximately 65 percent of recreation users originate is an area within a 50-road-mile radius (1 hour's drive) of Lake Ashtabula. (plate I-3.) This area extends east to the West Fargo-Fargo area and west beyond Jamesville and contains approximately 102,500 people.[1]

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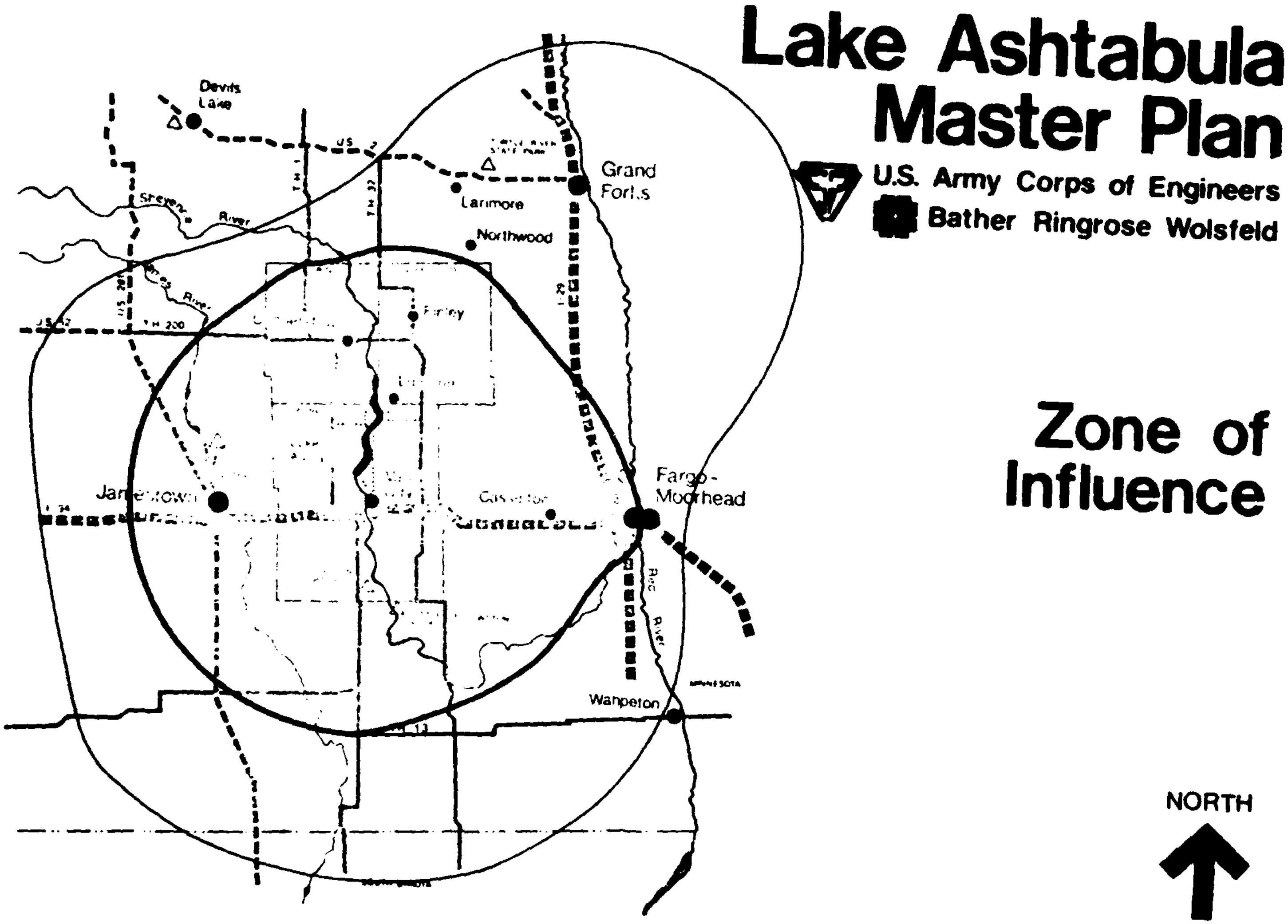
[1] Bather, Ringrose, Wolsfeld, et al. Lake Ashtabula Master Plan for Public Use Development and Resource Management, August 1977, p. 25.



Lake Ashtabula
Master Plan
U.S. Army Corps of Engineers
Bather Ringrose Wolsfeld
Zone of
Influence
NORTH
Devils Lake
Grand Forks
Larimore
Northwood
Finley
Fargo-Moorhead
Jamestown
Wahpeton
Red River
Sheyenne River
US 2
US 52
Minnesota

FIGURE 10

The secondary zone of influence, from which an estimated 25 percent of Lake Ashtabula's total visitation originates, is an area within a 60- to 100-road-mile radius of Lake Ashtabula. This zone contains approximately 296,500 people.[1]

An estimated 10 percent of the total Lake Ashtabula visitation comes from the summer tourists traveling through the North Dakota area.[1]

Inventory of Supply

In recent years, the zone of influence area and North Dakota in general have experienced a decline in population. However, present projections indicate that this will level out and stabilize in the near future. Past visitation figures for Lake Ashtabula show a yearly increase in use, and projections indicate this trend will continue to the year 2000. The only limiting factor to the existing or increased usage is project carrying capacity or the number of visitors the present facilities can comfortably accommodate without deterioration of resource conditions. It has been estimated that Lake Ashtabula can presently accommodate 144,392 to 189,471 visitors. Recreation days at Lake Ashtabula have been counted at the various recreation sites. In 1975, there were approximately 481,000 visitors or recreation days. Therefore, existing facilities or resources can comfortably accommodate 30 to 39 percent of the existing use.[2] It is reasonable to conclude that the 1975 demand for facilities exceeded the supply, given that the measures used for determining resource capacities are reasonable and adequately reflect existing conditions.

1 Ibid. p. 26.

2 Ibid. p. 31.

Estimated Future Demand

Extensive user surveys for Lake Ashtabula have not been conducted. As a result, all demand projections rely on statewide trends developed by the North Dakota State Outdoor Recreation Agency. These trends were then incorporated with population projections in the zone of influence, and a percentage of the total visitation was determined which could be assigned to Lake Ashtabula. This percentage is applied to future estimates of total demands in each zone in order to determine the visitation which could be expected at Lake Ashtabula in the future. Total demand for the year 2000 is projected at 541,400 to 558,400, an increase from 1975 of 13-16 percent.[1] As total demand increases and becomes more diverse, the developed sites will come under pressure to expand and to provide new facilities.

Impact of Raised Flood Pools

One proposed flood control structural alternative involves the temporary increase in pool levels at Lake Ashtabula. A current proposal is considering a lake level increase of up to 5 feet (which corresponds to up to 1,271 feet elevation above msl).

Increasing the depth of Lake Ashtabula will have an adverse impact on existing and proposed recreation facilities at the lake. The degree of this impact would depend on the extent and duration of increase in pool elevation. The larger the increase, the longer the pool will be above normal operating level (1266 feet). Elevated pool levels could last from 0 to 60 days, calculated from when the pool rises above 1266.0 feet until it recedes back to that level. The major impact will occur in late spring and early summer, well into the recreation season.

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[1] Ibid. p. 30.

Impact on Facilities

As pool levels increase above normal operating level, a decrease in usable recreation facilities and resources would occur. Some facilities would incur appreciable damage, but most would be operable after an appropriate maintenance and dry-out period. In order to determine specific impacts, details regarding soil, structural, and erosion characteristics must be considered on a site-by-site, facility-by-facility basis.

The major adverse effect would be that some structures would suffer flood damage because it would not be economically justifiable to relocate or flood proof them. Beaches, access roads, parking lots, and boat ramps would require some postflood maintenance in addition to an ample dry-out period. All easily moved equipment (picnic tables, trash containers, etc.) would be relocated and facilities having underground tanks would be filled with water prior to flooding to prevent uplifting.

Impact on Existing Facilities

At the 1271-foot elevation, all eight existing boat launching ramps and three swimming beaches would be inundated. Three parking areas would be reduced to 50-percent capacity and one concession stand would be covered (see figure 11). In addition, one entire tent camp area (Eggert's Landing), several individual regular campsites, and 5 percent of the picnic units would be affected. The bridge at Eggert's Landing would be impassable, blocking access to the camping area. Overall impact is appreciable for water-based facilities and minor for existing nonshoreline-oriented recreation development.

*The terms "loss" and "lost" as used in this report pertain to the usability of the facility or area at the given level. In most instances, these facilities will be usable after the pool has receded to normal operating level and appropriate maintenance performed.

FIGURE 11

Existing Facilities Affected

Facility	Total Existing Units	1271 #	%
Swimming Beach	3	3	100%
Boat Launches	8	8	100%
Parking Units	577	112	19%
Picnic Units	228	11	5%
Picnic Shelters*	7	-	
Camping Units*	131	7	5%
Concession Stand	2	1	50%
Access Roads	?	1001 1f	-
Vault Toilets*	8	-	-
Changing House	1	-	-

*Impact on most facilities at West Ashtabula Crossing (picnic shelter, camping area, toilets) and several at Katie Olson's Landing (picnic shelter, water supply) cannot be assessed with available information.

The Baldhill Dam area would receive no adverse impact at the proposed pool level, with the possible exception of the residence structure. Impacts on this structure and on most facilities at West Ashtabula Crossing and several areas of Katie Olson's Landing cannot be assessed with available information.

Preliminary Cost Estimates - Existing Facilities

As a result of the flooding caused by proposed pool level increases, affected facilities will require repair, relocation, or replacement. The preliminary cost estimate focuses on major recreation facilities and predicted damage, and reflects the cost of efforts to restore the recreation potential of the sites to their original state. This should not be interpreted as a final cost estimate, but rather, a generalization of what may be expected. Final cost estimates, when required, must be calculated on a site-by-site, facility-by-facility basis to ensure that preflood and postflood decisions on repair, replacement, or relocation of facilities are economically justifiable.

To determine the preliminary cost estimate, several assumptions have been made:

1. Maintenance and repair costs for access roads, boat ramps, swimming beaches, and parking areas will be 5 percent of their total replacement costs.

2. Repair costs for slab foundation structures (picnic shelters and changing house) will be 5 percent of their total replacement costs.

3. Wooden concession stands will require relocation at a cost of $1,000 per structure.

4. Open areas will have no appreciable damage.

5. All movable hardware (picnic tables, etc.) will be relocated prior to flooding.

6. Facilities with underground tanks (vault toilets and wat supply tanks) will be filled with water prior to flooding to prevent uplifting caused by buoyancy.

7. All significant recreation activities occur on project lands (i.e., no losses on private lands near the lake).

Total cost for each type of recreation facility is obtained by multiplying the unit cost, portion of replacement cost, and the number of units affected at each elevation. "Unit cost" is the amount required per unit of facility. "Portion of replacement" is the estimated fraction of total replacement cost needed to relocate, repair, or replace (as appropriate) the facility (see figure 12 for details).

Impact on Proposed Recreation Development

Figures 11 and 12 provide an overview of the resulting impact of suggested pool level increases of up to 5 feet above 1266 feet (normal operating level) on proposed recreational development of the Lake Ashtabula recreation areas. Recreation facilities discussed in this overview include proposed new development, renovated existing facilities, and other currently available resources. Because estimates are based on conceptual drawings within the recently revised master plan, exact locations of many facilities cannot be determined.

FIGURE 12 - Preliminary Cost Estimate of Impact on Existing Facilities

Facility	Unit Cost	Portion of Replacement Cost	# Units	1271' Total $
Parking	$2.00 sy[1]	.05	423 sy	$42.30
Access Roads	2.00 sy	.05	100 lf[2] 200 sy	20.00
Boat Launch				minimal
Picnic Area				minimal
Beach	5.35 sy	.05	833 sy	224.91
Concession Stand	25,000	.04	1	1,000.00
Campsite Units*	810 ea	.05	7	283.50
Fireplaces				minimal
Changing House	40,000	.05		
Potable Water Units*	3,000	.05		
Vault Toilets*	33,750	.05		
Picnic Shelters*	20,250 ea	.05		
Playground				minimal
Picnic Table	Movable			
Trash Container	Movable			
Grills	Movable			
TOTALS				$1,570.71

*Impact on most facilities at West Ashtabula Crossing (picnic shelter, camping area, toilets) and several at Katie Olson's Landing (picnic shelter, water supply) cannot be assessed with available information.

(1) Square yard.
(2) *Linear foot.*

Because fluctuations in the pool will be more frequent, increased shoreline erosion, water turbidity, and loss of utility for recreation could result. These factors could affect total recreation use and could significantly affect the scenic qualities of the shoreline. The extent of these impacts is not quanitfied because of the lack of adequate data. Further analysis is needed in future studies to determine the magnitude of these impacts.

At the 1271-foot elevation the major impact to proposed recreation development would be on shoreline-based facilities. All boat-launching ramps, swimming beaches, and boat tie-ups, as well as the extended shoreline development (Katie Olson's Landing) would be lost (figure 11). The Eggert's Landing bridge would be impassable, resulting in loss of access to the entire camping area. Impact to structural facilities would include the loss of one concession stand and a picnic shelter. Several picnic units and parking stalls would also be affected. With the exception of shoreline-based development (which would be a complete loss), adverse impact on facilities would be minimal.

Additional studies refining the impact of pool level increases are needed to more accurately determine the total effect of flooding on recreation facilities at Lake Ashtabula. More detailed pool-height duration values are required to further determine the period of encroachment into the summer recreation season. Additional refinement of cost estimates will also be necessary, as will an assessment of the impact of pool raises on user patterns.

Temporary pool level increases at the Lake Ashtabula (Baldhill Dam) project of up to 5 feet above normal operating level (1266.0 feet above msl) have been proposed as a structural flood control alternative. Pool elevations could exceed 1266.0 feet for up to a 60-day period, which would extend well into the spring/

summer recreation season, resulting in a significant decrease in available facilities and, in turn, affecting the amount and nature of recreational use.

Recreation structures within a flood area would require relocation prior to flooding, or repair or replacement when the pool recedes. The degree of damage and related costs increases as pool elevation increases. The major impact would be to water-based facilities such as boat ramps, beaches, and adjacent parking areas, which would be unusable during flooding but would suffer little damage. Some permanent structures could be affected, depending on water height. Several structures could be relocated, while cost considerations could justify replacement of others. Several facilities, though not directly affected by water, would be inaccessible as a result of flooding of access roads.

User patterns would also be affected during pool level increases. Water-oriented activities can be expected to decrease drastically because of the unusable facilities. Nonwater-based activities would also decrease as a result of flooding of or inaccessibility to the area.

DEAD COLT CREEK TRIBUTARY DAM

Erecting an 80-foot-high dry dam on Dead Colt Creek approximately one-half mile upstream of its confluence with the Sheyenne River would affect the limited fishing and canoeing which are possible whenever water levels are sufficient. Use of Dead Colt Creek would probably diminish as a result of recreation opportunities now being planned by the State Water Commission for the lake. The proximity of the project site to the Sheyenne River would also tend to minimize canoeing demand at Dead Colt Creek. Both the dry dam and a recreational impoundment lake might indirectly affect the fishery of the Sheyenne River since Dead Colt Creek is a spawning area for the river. A dry dam would subject 340 acres to temporary inundations; however, no significant impacts on game species have been identified.

As a permanent pool, this measure could impound a modest public recreational lake, yielding approximately 150 surface-water acres with an average depth of 15 to 18 feet. An obvious need exists in the Lisbon area for this kind of resource, as evidenced by the local interest, concern, and determination to develop the project site through the North Dakota State Water Commission and the Department of Parks and Recreation, with cost-sharing funds from the National Park Service. There is also a possibility of obtaining participation from the Corps of Engineers in developing this flood control and recreation project. However, because the economic feasibility of the project is marginal (i.e., estimated benefit-cost ratio of 1.1), Corps involvement seems unlikely. The cost of meeting Corps construction standards could easily drop the benefit-cost ratio below 1.0.

Two public recreation areas are currently proposed in conjunction with this flood control measure. These areas will have facilities for boating, picnicking and swimming, and will require an access road. Estimated costs are shown in the following figure:

FIGURE 13 -Recreation Areas Cost Estimate (1)

1.	Concrete Boat-Launching Ramp - Lump Sum	$ 7,500
2.	Boat Dock - Lump Sum	1,500
3.	Barrier Post - 160 @ $15.00	2,400
4.	Picnic Tables - 30 @ $250.00	7,500
5.	Grills - 15 @ $150.00	2,250
6.	Trash Receptacles - 8 @ $300.00	2,400
7.	Comfort Station - 2 @ $7,500	15,000
8.	Picnic Shelter - 4 @ $4,000	16,000
9.	Traffic Surface Gravel - 4000 C.Y. @ $5.00	20,000
10.	Beach Sand - 1000 C.Y. @ $5.00	5,000
11.	Fencing - 50,000 L.F. @ $0.65	32,500
12.	Roadway - Lump Sum	15,000
	Subtotal	$127,050
	Contingencies	12,650
	Construction Inspection	12,650
	Contract Administration	12,650
	TOTAL	$165,000

(1) Source: "Preliminary Engineering Report - Dead Colt Creek Dam," North Dakota State Water Commission, November 1979.

Details of the two public recreation areas follow. Area number one is proposed to have two picnic shelters and four smaller areas having picnic tables, grills and trash receptacles. This area will also have a boat dock and a concrete boat-launching pad. A swimming beach will be provided, with a comfort station and changing house located nearby. Facilities for this area will be located along a loop road. The beach will be away from the boat landing and will separate most of the picnicking area from the boating area. Picnicking spots are also proposed near the beach and boat docks.

Recreation area number two will be smaller than the first and located at the end of the access road. No boat docks or beach are proposed here. Instead, this area will be basically a picnicking area. There will be two picnic shelters and two smaller picnicking areas, with picnic tables, grills and trash receptacles.

The access road to the proposed recreation area will be approximately 7,000 feet long. Part of the road will follow an existing trail.

In conclusion, the need for public water-based recreation in the project area is acute.(1) The North Dakota Water Commission has promised support for this recreational Lake; however, subsurface complications at the damsite and recent cutbacks in LAWCON funding have cast doubts on the implementability of the project.

WETLANDS DEVELOPMENT

Generally, restoration or creation of wetland areas offers potential public recreational opportunities for hunting (primarily waterfowl), nature observation, trailways, and fishing. In the project area, it appears that the greatest potential recreation opportunities would be hunting and nature observation activities (i.e., trailways are not near urban areas or other large trail systems, and water depth is not sufficient to sustain a fishery over winter).

(1) 1975 and 1980 SCORPs.

Low intensity small-game hunting demand is anticipated, and limited facility nature observation would be appropriate in this project area. Costs associated with recreational facilities would be minimal, and benefits would be modest. Recreation facilities provided with this project would probably be limited to small, gravel parking lots with short, aggregate trails or possibly boardwalks. The feasibility of these recreation facilities would usually be above unity. The exact location, size, design, and scale of the facilities will need to be analyzed and coordinated in future planning efforts.

FARM RING LEVEES

Farm ring levees offer very little potential for recreation opportunities and/or impacts. Private ownership of the lands associated with this flood control measure excludes public use. Therefore, no attempt is made in this report to identify potential recreation opportunities associated with this alternative.

SMALL PERMANENT POOL BEHIND KINDRED DAM

One flood control alternative being evaluated is the development of a small reservoir referred to as Kindred Lake. As currently proposed, Kindred Lake would be located about 70 miles above the mouth of the Sheyenne River and about 5 valley miles upstream of the community of Kindred, in Richland County, North Dakota. This alternative consists of a multiple-purpose dam which would support a small impoundment (1500 to 2200 water-surface acres in size) for flood control, water quality control, recreation, and fish and wildlife.

Open and rolling cultivated areas and grasslands with wooded stream valleys characterize the topography of the proposed lake site. About 90 percent of the land is farmed, and the remainder consists of woodland or pasture. In most locations, the margin of the proposed reservoir is timbered and would provide suitable

recreation sites for picnicking and camping. Timber in the reservoir area consists principally of basswood, bur oak, ash, hackberry, and elm. Several small tributary streams and a few small lakes and ponds exist in the area.

Determining the appropriate scale of public recreation development at any water resource project depends on resource capabilities and public demand and need for facilities.

In this instance moderate recreation demand/need for facilities exists as discussed below.

The North Dakota Outdoor Recreation Agency is currently finalizing its update of the 1980 State Comprehensive Outdoor Recreation Plan (SCORP). The State has contracted with the North Dakota State University to prepare and administer new recreation use surveys for the purpose of generating new recreation demand projections. This information will then be reviewed in light of updated supply inventories to generate revised recreation resource needs estimates. A review of the following resource-needs estimate (Figure 14) reflects relatively low needs for several water-based recreation opportunities within the region of the proposed reservoir. However, latent demand for water-based recreation in the Kindred area is potentially high.

FIGURE 14 - Region 5 Outdoor Recreation Resource Needs

Resource Needs	1975	1980	1985	1990
Picnicking:				
Number of Tables	554	604	653	699
Camping:				
Number of Sites	94	121	143	176
Swimming:				
Number of Beaches	2	2	3	3
Boating (sailing/waterskiing)				
Number of Water Acres	-	142	314	484
Number of Ramps	-	-	-	-
Fishing:				
Number of Water Acres	-	-	-	-
Bicycling:				
Number of Miles of Trail	13	15	17	19

*1975 North Dakota SCORP, N.D. State Outdoor Recreation Agency, pp. 5.2-.18. The 1980 SCORP has not been sourced for this needs list because its new format is not suitable for this table.

There are a number of resource constraints which may limit the scale and type of recreation development potentials at Kindred Lake. A brief discussion of these factors follows:

Soils and slopes - Soils in the reservoir area are sandy and subject to erosion. This is compounded by the relatively steep slopes which characterize much of the river corridor. Recreation developments will need to be carefully located to minimize erosion impacts, and intensive use of the shoreline will need to be avoided.

Water Quality - The quality of the water at Kindred Lake would probably be similar to that of Lake Ashtabula; that is, overall quality would be marginal. Occasional algal blooms and high bacteria counts are anticipated, and turbidity

will be an increasingly significant problem as the lake ages. Although marginal water quality would detract from the user experience, swimming and waterskiing are viable recreation activities at the lake.

Impact of Reservoir Operating Plans on Aesthetics - In order for the reservoir to function adequately for flood control, fall drawdown and occasional flooding of lands above the normal lake levels will be necessary. This would have adverse impacts upon the shoreline vegetation of public recreation lands, as long periods of inundation will cause trees and shrubs to die. Larger floods (those over a 20-year flood frequency level) would substantially affect the recreational setting by killing many trees. Such a situation strongly affects aesthetics and the recreation experience of users and, in turn, user-day values and total visitation.

Because of the moderate need for water-based recreation in the Kindred area and the area resource development and aesthetic limitations, the appropriate scale of recreation development is difficult to determine. This problem is compounded by the fact that non-Federal sponsorship of recreation developments is required, and close planning coordination between cost-sharing sponsors would therefore be imperative. A detailed plan of development will need to be prepared in the future, assuming this alternative is authorized for further study.

Generally, recreation development associated with multiple-purpose reservoirs like Kindred Lake are economically feasible, with benefit-cost ratios usually ranging from 1.5 to 5.0. However, because the recreation setting may be aesthetically marginal due to vegetation loss after flooding, the unit-day values may be lower for Kindred Lake than for most multi-purpose recreation projects. Therefore, the overall recreation benefit to cost ratio would probably range from 1.5 to 2.5.

RELOCATIONS AT VALLEY CITY AND/OR LISBON

Generally, potential is high for recreation associated with relocation of structures from flood prone areas since the land is then converted to open,

public space which fosters many recreation opportunities. When the relocations occur in an urban setting where demand for recreation facilities is high, recreation potential is increased even more.

Since the land associated with this flood control measure involves only 10 acres of public land in each city, community or neighborhood parks which could incorporate a linear trail system would appear to be the most feasible recreation development. A community and/or neighborhood park would typically provide facilities for numerous day-use activities such as picnicking, softball, soccer, tennis, and trail activities such as bicycling, pleasure walks, and cross-country skiing.

Regional and local demand for specific types of recreation facilities should be determined and an analysis of the suitability and limitations of pertinent sites should be done before development plans are prepared. A detailed analysis would need to involve local publics and government entities. Detailed planning would be part of future study efforts if this flood measure is authorized.

RELATED STUDIES

In order to adequately evaluate alternatives, available base data for many activities were collected and projected (see pages I-8 through I-13 for details). Hunting initially appeared to be an area of concern because no evaluation was available on hunter use of the Lake Ashtabula or Kindred areas. Obtaining this information was considered necessary because hunting is an activity which is participated in intensively by a significant portion of North Dakotans, and which could affect net project benefits and/or mitigation requirements. The Corps therefore acquired the services of a consultant to conduct a mailed survey of hunters in the Lake Ashtabula and Kindred areas of Southeastern North Dakota, and to document the results.

Another related study which the Corps developed to help evaluate alternatives was "Montary Evaluation of the Terrestrial Wildlife Resources of Sheyenne River, North Dakota." This study was an attempt to identify the monetary value of wildlife in the project area. These hunting studies are valuable because they help document the existing condition without the project. However, this information ultimately has had limited value in evaluating recreation potentials for two reasons:

(1) The Kindred Lake/Dam flood control measure is no longer being considered for further study, and the existing condition data are therefore no longer necessary.

(2) The small-scale impacts associated with the Lake Ashtabula alternative would not produce a significant change in hunter use of the area.

These related reports are referred to in the main report, especially in the context of wildlife habitat mitigation lands, which the above conclusion that no impact will occur on the hunting value cannot be extrapolated to include. In the "Monetary Evaluation of Terrestrial Wildlife Resources," it is concluded that small changes in wildlife habitat are not reflected with corresponding changes in hunting use, and a habitat-based evaluation is recommended to determine wildlife mitigation lands.

Exhibit C includes a summary of the contractor's report on hunting use and the "Monetary Evaluation of the Terrestrial Wildlife Resources."

PHASE I GDM SHEYENNE RIVER, NORTH DAKOTA

RECREATION RESOURCE ANALYSIS

APPENDIX I

Route of Scenic Highway topic at meeting

by VI KJELLAND

"If we're of one voice, if we're patient, and if we can get our grandchildred interested in the project, we will get a paved road to Fort Ransom," was the advice that Snorri Thorfinnson gave the large group of people at Bear Creek Hall in Fort Ransom last Tuesday evening.

The group had gathered to attend a meeting, and voice their opinions, on the proposed paved Viking Scenic Highway, which would extend from Little Yellowstone, to Fort Ransom, and thence to Lisbon, a distance of about 36 miles. Estimated cost of the proposed highway is 2 *million* dollars.

Bob Bohlken, Scenic Highway committee chairman, was in charge of the meeting, which was opened by a welcome from Ed Manson, Mayor of Fort Ransom. He stated that residents of Fort Ransom were very interested in getting a hard surfaced road into the city and he felt that the residents of the town were pretty much in accord as to the route of that highway.

Virgil Anderson, a member of the highway committee, gave a brief history of what has been done in the last four years, which was when the project was first started. He pointed out that the first meeting regarding the proposed highway was held in 1973 at Fort Ransom with Se[illegible] Quentin Burdick in attendance. After that, several trips to Bismarck were made by members of the committee to discuss the proposed highway with Walter Hjelle, State Highway Commissioner. After these discussions, it is hoped by the highway committee that funding will be available from the state, if someway is found of paying for the grading, etc., of the road, to bring it up to specifications for surfacing.

John Norberg, Superintendent of the proposed state park at Fort Ransom, also spoke briefly at the meeting. He said that the residents of Fort Ransom would have

(Continued on Page 2)

Scenic Highway...

(Continued from Page 1)

to be the ones to decide just exactly where the park entrance should be, and various other aspects of the park planning. A public meeting in regard to this will be held sometime in early February, and the date will be announced far enough in advance so all interested can make plans to attend.

It was pointed out by Bohlken, that the highway would be classified as a scenic one and that the speed limit on the highway would be 50 MPH instead of the usual 55 MPH.

Ernie Fadness, chairman of the Ransom County Commissioners, told the group the county's problem is in finding the money to do the preliminary road work. Fadness explained that at the present time, the bridges in Ransom County have priority as far as road construction monies were concerned. "As soon as all of them are repaired or reconstructed, then the county can look to more paved roads," he said.

Bernie Anderson, state representative from the 27th district, also spoke to the group. "There are many things involved in this project," he told the group. "The residents of the Fort have to agree among themselves just how they feel about this proposed highway. Some will benefit greatly by the highway and others will be inconvenienced. Perhaps there will be hard feelings, but there has to be a spirit of give-and-take among the residents," he went on. He compared Fort Ransom to the little town of Epping in the state basketball tournament. "Fort Ransom may not be large, but it has a lot to offer the other residents of the surrounding area," he concluded.

EXHIBIT A - Local Newspaper Article (Source and Date Unknown)

EXHIBIT B
SHEYENNE RIVER - CANOEING POTENTIAL

SHEYENNE RIVER

The lower Sheyenne is one of North Dakota's most scenic rivers. Begir ig on the county road bridge two miles south of Valley City and ending at Horace, the river offers a wide variety of changing scenery. It meanders through areas rich in culture and history, wildlife and woods. The canoeist may see beaver, musk-rat, mink or white-tailed deer in their native habitat. Many shaded banks offer serene rest stops and picnic sites. Overnight camping, picnicking and parking fa-cilities are available at Clausen Springs Recreation Area and Little Yellowstone Park. Food and water should be carried on the trip as nearby towns are many miles apart. A campstove is recommended for cooking due to privately owned adjacent land.

The 155-mile trip can be completed leisurely within five days. Intermediate pick ups can be planned at Kathryn, Fort Ransom, State Highway 32 at Lisbon, State Highway 27 east of Lisbon, State Highway 18 west of Walcott, Kindred and Horace. The mileage between points is listed in the accompanying brochure. Canoeists should watch for obstructions such as deadfalls and overhanging branches. In addition, lowhead dams will be encountered three miles northwest of Kathryn (Brown Dam), one mile east of Kathryn (Kathryn Dam), the Lis-bon Dam, and the Fort Ransom Dam. Portaging around these areas is necessary as they are extremely danger-ous.

The Fort Ransom area offers many unique sights. Lo-cated here is Fort Ransom Historic Site, Indian burial mounds and pictographs (picture writing on stone). An area between Little Yellowstone Park and Fort Ransom has been designated as Fort Ransom State Park. Camping and picnicking facilities will be available as it is developed.

Spring and early summer are the best times for ca-noeing, though the water level is suitable nearly all summer. To check current local conditions, information is available at the Soil Conservation Service (SCS) in Lisbon, ND (701-683-4531).

From "North Dakota Canoeing Water" North Dakota Parks and Recreation Department

SURVEY OF HUNTERS, SHEYENNE RIVER VALLEY, NORTH DAKOTA

SUMMARY[1]

STATEMENT OF PURPOSE:

The purpose of the study is to establish the level and type of hunting in the Kindred Dam and Lake Ashtabula areas based on a stratified random sample of hunting license holders in ten counties immediately adjacent to these areas. The material presented develops a profile of the hunters and projects hunting use to the year 2005.

This study focuses on two segments of the Sheyenne River. The first is Lake Ashtabula in Barnes, Griggs, and Steele Counties. Baldhill Dam, at the downstream end of the Lake, is approximately 12 highway miles from Fargo, North Dakota.

The second area is the site of the proposed Kindred Dam and associated reservoir. The proposed reservoir would be located in Richland and Ransom Counties, approximately 20 miles from Fargo, North Dakota. Presently, the Sheyenne River is free-flowing through this stretch.

The mailed survey was conducted from February to April, 1980. The survey questionnaire focused on hunting activities in the last five years (1975-1979), with particular emphasis on the 1979 season. The survey was distributed to individuals who purchased general hunting licenses in ten counties in Southeastern North Dakota.

[1] This is a summary of a survey and subsequent report detailing hunter use trends, hunter characteristics, and implications of the energy crisis in the Kindred and Lake Ashtabula areas. This report was prepared under contract by Weston, Inc. for the St. Paul District, Corps of Engineers.

Kindred Dam Area

The table below presents the general characteristics of the Kindred area hunter. The reader will note that the distributions of total years hunted and the years hunted in North Dakota are skewed right (positive). That is, there are more hunters with experience less than the mean. The distribution for years hunted in the last 10 years is, as expected, skewed left (negative).

Kindred Area Hunter Characteristics

	Mean	Mode	Standard Deviation	f
Total years hunted	17.30	10.0	12.88	4148
Years hunted in N.D.	15.13	4.0	11.94	4148
Years hunted in last 10 yr.	7.55	10.0	2.85	4148

With respect to their intention to hunt, 94.0 percent of the respondents will hunt in 1980 and 35.2 percent will hunt in the Kindred area.

Using the results of the survey, it is possible to estimate the number of hunters who intend to hunt in the Kindred area in 1980. To do this, the responses of all individuals must be used. A total of 10,789 indicated that they would hunt in North Dakota in 1980. When this is adjusted for nonrespondents the total number will be 19,706. Of these, 6,066 (expanded) indicated that they would hunt in the Kindred area. This compares with 5,454 who stated that they hunted in the area in 1979. Thus, if these results are representative, there will be an 11.2 percent growth in this area.

On the average, the Kindred area hunter travels 45.7 miles to hunt. The minimum distance is 1 mile and the maximum is 300 miles. The price of gas affected the hunting activities of 43.3 percent of the hunters who responded and 57.1 percent expected gas prices to affect their hunting in 1980. An additional 1.1 percent said that the price of gas <u>may</u> affect their activities.

When asked to explain how the price of gasoline affected them, the respondents indicated that they would not hunt as often, would hunt closer to home, and that it cost them more to hunt, taking a greater proportion of their discretionary income.

When respondents who hunted in the Kindred area in the last five years were asked why they hunted in that area, they indicated that the primary reasons were that it was close to home, that they had good success in the past, that there were nonposted lands available and that there was a high number of animals.

Lake Ashtabula Area

Using the results of the survey, it is possible to estimate the number of hunters who intend to hunt near Lake Ashtabula in 1980. To do this, the responses of all individuals must be used. A total of 10,789 indicated that they would hunt in North Dakota in 1980. When this is adjusted for nonrespondents the total number will be 19,706. Of these, 5,169 (expanded) indicated that they would hunt near Lake Ashtabula. This compares with 4,300 who stated that they hunted near Lake Ashtabula in 1979. Thus, if these results are representative, there will be a 20.2 percent growth in hunting in the area.

Note that these numbers are conservative in that the survey did not include all North Dakota hunters or out-of-state hunters. Thus, the results of the survey underestimate recreational use near Lake Ashtabula.

The pattern of hunting activity within the last five years is shown on the table below which indicates that activity declined in 1979 from the 5-year peak of 1978. This decline is similar to that previously observed for the Kindred area.

Lake Ashtabula Hunting Use

1975-1979

	Survey Response	Expanded
1975	2036	3719
1976	2171	3965
1977	2441	4458
1978	2597	4743
1979	2354	4300

On the average, the Lake Ashtabula area hunter travels 61.3 miles to hunt. The minimum distance is 1 mile and the maximum is 350 miles. The price of gas affected the hunting activities of 48.6 percent of the hunters who responded, and 63.1 percent expect gas prices to affect their hunting in 1980. An additional 2.2 percent said that the price of gas may affect their activities.

When asked to explain how the price of gasoline affected them, the respondents indicated that they would not hunt as often, that it cost them more to hunt, and that they would hunt closer to home.

When respondents who hunted in the Lake Ashtabula area in the last five years were asked why they hunted in that area, they indicated that the primary reasons were they had good success in the past, it was close to home, nonposted areas were available and there was a high number of animals.

EXHIBIT C(2)

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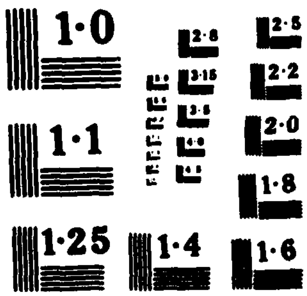
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MONETARY EVALUATION OF THE TERRESTRIAL WILDLIFE RESOURCES, SHEYENNE RIVER, NORTH DAKOTA

ABSTRACT

A monetary evaluation of the hunting resource in the Kindred Dam and Lake Ashtabula areas was conducted in order to determine the effects of the proposed project on the wildlife resource. A direct relationship is assumed between the dollar value for hunting and the acres of wildlife habitat. Two separate methods, the travel cost method and the unit day method, were used to place a dollar value on the existing hunter use of the Kindred Dam and Lake Ashtabula areas. The value for the Kindred Dam area is $1,356,000 using the travel cost method, and ranges from $341,000 to $1,550,000 using the unit day method. For the Lake Ashtabula area, the value is $723,000 using the travel cost method, and ranges from $170,000 to $1,015,000 using the unit day method. Future with and without project conditions in the Lake Ashtabula area are analyzed using future-use predictions for the region from the 1980 North Dakota SCORP. A 7-percent increase in the without project value of the hunting resource is projected for the year 2080. Since the proposed action would disturb less than 1 percent of the available land, future with project values are projected to be the same as the future without project values, indicating no impact on the hunting value. Although the monetary evaluation predicts no impact on the hunting resource, no firm conclusions regarding the effects on wildlife have been drawn. Since the effects of small scale impacts on wildlife are not reflected by changes in hunter use, a wildlife or habitat based model is recommended for describing impacts on the wildlife resource.

INTRODUCTION

Many factors such as public opinion, economic benefits, and environmental impacts are considered and compared before the best solution to a flood control problem is determined. A "common denominator" of economic value becomes a useful tool in this comparison process. Since the project's effect on wildlife is an important part of the environmental impacts, it is necessary to place an economic value on the wildlife resource for comparison purposes.

The economic value of wildlife is especially difficult to determine, because the nature of economics makes it hard to place a monetary value on something which is not traded on the open market. For example, it is hard to place a dollar value on such things as scenic qualities, wildlife observation, good deer habitat, or other "non-consumptive" uses. In spite of these limitations, an indicator of the economic value of wildlife is of great use.

The objective of the following monetary evaluation is to use the value of hunting as such an indicator in the Kindred Dam and Lake Ashtabula areas. Since hunting value, while not equivalent to wildlife value, is directly related to the abundance of game species in the area, it is used as an indicator of the wildlife resource value.

Two different methods, travel cost method and unit day method, were used to estimate annual hunting value. The travel cost method was used because it is recognized as a cost-effective method which yields a good estimate of the resource value (ER 1105-2-300, Appendix 1 to subpart k; Dwyer, et al., 1977). The unit day method is used because it is a traditional method which has been widely applied, and therefore provides useful comparison values.

Annual hunting values were determined under existing conditions for both the Kindred Dam and Lake Ashtabula areas. Values were also determined for the Lake Ashtabula area under future with and without the project conditions. The difference

between these future with and without values is the dollar estimate of the annual gains or losses in hunting value which would result from project construction. This dollar gain or loss is then converted into an acreage equivalent in order to estimate wildlife mitigation lands.

TRAVEL COST METHOD - EXISTING CONDITIONS

METHODOLOGIES

The travel cost method is based on the relationship between distance to the site and demand (number of users) at the site. This relationship is used to construct a demand curve which shows how demand at the site declines with increases in the cost of using the site (distance traveled is converted to cost using a cost per mile conversion). The area under the demand curve is the dollar value estimate of the consumers' surplus[1] enjoyed by the area's hunters. This value is then added to all site specific expenditures to estimate annual hunter willingness-to-pay for use of the area.

The travel cost method for evaluation of hunter use in the Kindred Dam and Lake Ashtabula areas follows six steps: (1) designation of an area of influence for both dam sites, (2) survey of hunter use in these areas, (3) use of these data to construct individual demand curves, (4) adjustment of the individual demand curves for the effects of travel time, (5) construction of the site-specific aggregate demand curve, and (6) calculation of total hunter willingness-to-pay. The methodologies used in this evaluation follow examples and methods given in ER 1105-2-300 and by Dwyer, Kelly, and Bowes (1977).

[1] "Consumers' surplus" is the amount above what is already charged that a user would be willing to pay for use of the site. For example, some moviegoers would be willing to pay $6.00 to see a movie even though the price is only $4.00. In this example, the consumers' surplus is $2.00. "Willingness-to-pay" is the sum of consumers' surplus and the actual expenditures.

The following is a detailed explanation of the methodologies associated with the six steps outlined above, given the context of evaluation of hunter use in the Kindred Dam and Lake Ashtabula areas. A simplified example and brief explanation of the general procedures for the travel cost method are given in Figure 1.

Area of Influence:

Before the area of influence can be established, the boundaries of the site must be delineated. Since this travel cost evaluation is based on data collected in the hunter survey, the site boundaries are taken to be the same as the hunter survey site boundaries (see Plate 1). The area of influence and the zones within this area are constructed around the centroid of the site boundaries.

The area of influence is designated as the area between 0 and 90 miles from the centroid. The outer limit of the area of influence was set at 90 miles because over 90 percent of all use came from inside this area, and use from zones outside this area was very close to zero (Hunter Survey, 1980). The area of influence is broken into distance zones which represent an increase of 10 miles in the one-way trip distance (see Plate 1). The number of visits, population, and cost of travel from each of these zones are used in construction of the demand curves.

Site Survey:

The data which form the basis of this travel cost evaluation are taken from a mailed survey of hunters in southeastern North Dakota. This survey was conducted by the Corps from February to April 1980, and provides the best available information on how many days each hunter hunted, and the distance each hunter traveled to hunt. These data are used to calculate the number of days hunted from each distance zone (see Tables 1 and 2).

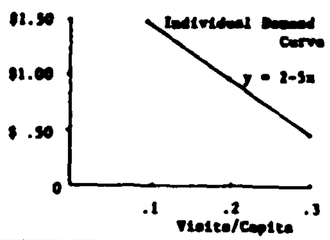
Construction of an Individual Demand Curve:

An individual demand curve shows how visits vary with increases in the cost

Figure 1: Summary of the travel cost methodology with a simple example.

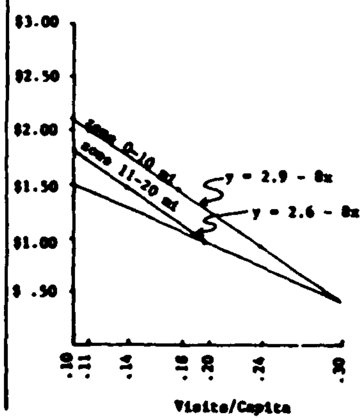
Methodology	Example		
(1) Set up distance zones and sample a representative portion of the zone to determine the relative number of visits between each zone.	**Zone**		**Visits**
	0-10 miles		300
	11-20 miles		150
	21-30 miles		50
(2) Determine the population of the portion of the zone which was sampled during the survey.	**Zone**		**Population**
	0-10 miles		1,000
	11-20 miles		750
	21-30 miles		500
(3) Calculate the cost of travel from each zone (miles X cost per mile). Use steps 1 and 2 to calculate the visits per capita for each zone.	**Zone**	**Cost**	**Visits per Capita**
	0-10 miles	$.50	0.3
	11-20 miles	1.00	0.2
	21-30 miles	1.50	0.1

(4) Plot the visits per capita from each zone against travel cost from the zone. Use regression analysis to determine the line of best fit (Individual Demand Curve).



(5) Adjust for the effects of travel time by constructing a new demand curve for each zone. The slopes of these new curves are based on the slope of the demand curve derived in step 4.

New slope = old slope X 1.6
(see page



(6) From the curves found in step 5, read the levels of visitation from each zone which would be anticipated at various trip costs. These are the visitation rates adjusted for the effects of travel time.

Trip Cost	Zone-visits per capita 0-10 Mi.	11-20 Mi.	21-30 Mi.
$ .50	.30		
1.00	.24	.20	
1.50	.18	.14	.10
2.00	.11	0	0
2.50	0		

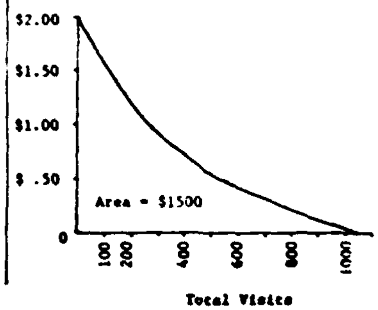
(7) Multiply the rates of visitation from step 6 by the total population of the zone to get the total visits for each zone at the various trip costs.

Trip Cost	Zone (total visits) 0-10 Mi. Pop. 1500	11-20 Mi. Pop. 2000	21-30 Mi. Pop. 1800
$ .50	450		
1.00	360	400	
1.50	270	280	180
2.00	165	0	
2.50	0		
	165	280	550 1030

(8) The information from step 7 can then be used to predict the total number of visits to the site which would occur with increases in the trip cost. The sum of the first number in each column represents the total number of visits which can be expected under current trip costs. The sum of the second number in each column represents the total number of visits which would be expected if trip costs increased by $.50.

Additional Trip Costs	Total Visits
0 (Current trip cost levels)	1030
$.50	550
1.00	270
1.50	165
2.00	0

(9) Plotting the data from step 8 gives the aggregate demand curve. The area under the curve can be determined with a planimeter and is equal to the consumers' surplus enjoyed by users of the area. Consumers' surplus is added to any site-specific expenditures to obtain the estimate of the annual willingness-to-pay for use of the area.



of travel to the site. For this curve, three sets of data are necessary: (1) visits from each zone, (2) population of each zone, and (3) a constant for converting miles into dollars.

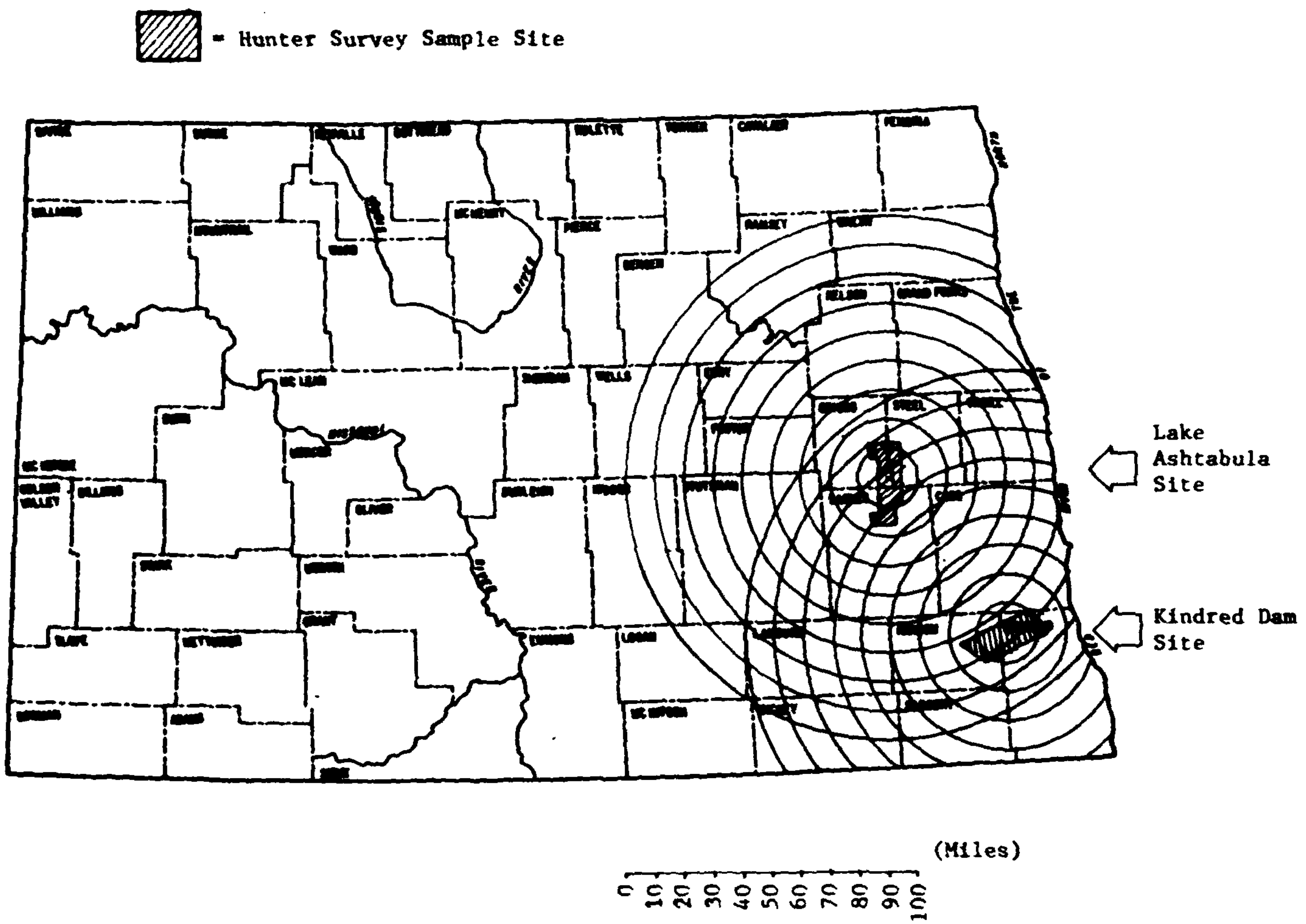
The visits from each zone are assumed to equal the number of days hunted from each zone. The population of each zone is determined from the 1977 estimates by the Bureau of Census (U.S. Department of Commerce, 1979), and a map of North Dakota showing distance zones, townships, and cities. The population of a zone is the sum of the populations of all its townships and cities. The visits per capita are determined by dividing the number of visits from a zone by the population of that zone.

The other factor necessary for construction of the individual demand curve is the travel cost from the different zones. Travel costs are calculated using 1979 Federal Highway Administration estimates (Ullman, 1979). The basic value of 12.6¢/mi. includes cost of fuel, oil, maintenance, accessories, parts, tires, and taxes on these items. This value is then multiplied by 2 to account for round trip costs, and divided by 2.7[1] to compensate for more than one hunter per vehicle. The resulting constant is 9.3¢/mi., and represents the average per-mile cost to each hunter for travel to the hunting site. The product of this per-mile cost figure and the miles from each distance zone gives the travel cost from that zone.

Plotting visits per capita against cost gives the individual demand curve (see Figures 2 and 3). Regression analysis of these data specifies the line of best fit, and gives the equation which describes the relationship between travel cost and visits per capita. This equation is used to adjust the visits per capita for each zone. The adjusted visits per capita for the Kindred Dam and Lake Ashtabula areas are given in Tables 1 and 2.

[1] Values selected from information given in ER 1105-2-300 (pg. A-69).

PLATE 1: Zones of Influence



Adjustments for Travel Time:

The individual demand curve constructed in the previous section shows how the visits per capita decline with increases in travel distance (converted to cost). It is important to realize that increases in travel distance not only result in increases in travel cost but also in travel time. Travel time is an important factor in determining use (i.e., those with high travel time are less likely to use the area). Therefore, failure to consider travel time causes misspecification of the demand curve.

For accurate specification of the demand curve, the travel time variable must be held constant so that the effects of increased costs on visitation can be accurately observed. Since travel time for one zone is different from any other zone, holding travel time constant means a separate demand curve must be constructed for each zone.

It is assumed that the demand curves for all zones have the same slope. The slopes of new demand curves are a function of the slope of the original demand curve (Dwyer, 1977), and are expressed in the following relationship:

$$M_n = M_o\ (1 + hk)^{(1)}$$

where M_n = slope of new demand curves

M_o = slope of original demand curve

h = 1/3[(2)] of the hourly wage rate in the area of residence (h = \$1.50 in this evaluation)

k = a constant which relates the rate of travel to the cost per mile or rate of cost of operating the vehicle. Specifically:

$2 \div (50 \text{ mi/hour} \times .093 \text{ \$/mi}) = .429 \text{ hrs/\$}$

The y-intercept necessary for specification of the equation for a zone's new demand curve may be determined through algebraic means using the coordinates of the data point for the zone.

(1) Derived from examples given in Dwyer et al., 1977, pgs. 124-25.

(2) Values selected from information given in ER 1105-2-300 (pg. A-69).

The new demand curves produced by the above calculations are steeper (more negatively) sloped than the original demand curves (see Figures 4 and 5). Given these new curves, the rates of visitation for different cost levels (Tables 1 and 2) change to reflect the effects of travel time. The resulting numbers specify how increased costs will affect visits per capita for each zone surrounding the Kindred Dam and Lake Ashtabula sites (see Tables 3 and 4).

Construction of an Aggregate Demand Curve:

The aggregate demand curve is based on the individual demand curve constructed in the previous section. It expands the individual demand curve by showing how many total visits would be made with increasing costs.

The aggregate demand curve is constructed by multiplying the visits per capita for a zone at a given cost level by the population of that zone. Adding these figures from each zone gives the total number of visits at that cost level (see Tables 5 and 6 for a summary of these calculations).

Plotting these total visits against the cost levels produces the aggregate demand curve. The aggregate demand curves for the Kindred and Lake Ashtabula areas are shown in Figures 6 and 7.

The area under the aggregate demand curve is determined with a planimeter, and is an estimate of the consumers' surplus enjoyed by the area's hunters.

Calculation of Willingness-to-Pay

The consumers' surplus determined in the previous section is added to any site-specific expenditures to give total willingness-to-pay. The Water Resources Council and ER 1105-2-300 state that "onsite time costs should be included in the total willingness-to-pay for access to the site" (ER 1105-2-300, p. A-69). In this monetary evaluation, onsite time costs are treated as the only site-specific expenditures, and are added to the consumers' surplus to determine total willingness-to-pay.

Onsite time costs are calculated using the product of 1/3 of the average hourly wage rate and the number of hours spent hunting. This dollars per visit value is then multiplied by the number of visits to get a dollar value for onsite time. Of the three variables used in the onsite time calculations, only the number of visits was determined through survey techniques.

RESULTS

Site Survey: Tables 1 and 2 summarize the number of days hunted from each zone as determined from the survey of hunters in southeastern North Dakota. See Plate 1 for map showing the zone boundaries.

Construction of the Individual Demand Curve: Population for each zone is calculated so that the visits per capita for each zone can be determined (see Tables 1 and 2). The individual demand curves for the Kindred Dam and Lake Ashtabula areas are shown in Figures 2 and 3. Regression analysis is then used to determine the line of best fit and to adjust the visits per capita.

Table 1: Kindred Dam Area

Zone	Cost(1)	Visits(2)	Population(3)	Visits/Capita(4)	Regression Adjusted Visits/Capita(5)
0-10 mi	$.47	9410	1270	7.410	4.510
11-20 mi	$1.40	8442	5914	1.430	2.510
21-30 mi	$2.33	7938	13926	.570	1.390
31-40 mi	$3.27	5609	22829	.246	.775
41-50 mi	$4.20	11209	73685	.152	.432
51-60 mi	$5.13	2486	4799	.518	.239
61-70 mi	$6.06	1578	6681	.236	.133
71-80 mi	$7.00	2526	20260	.125	.074
81-90 mi	$7.93	648	4373	.148	.041

Table 2: Lake Ashtabula Area

Zone	Cost(1)	Visits(2)	Population(3)	Visits/Capita(4)	Regression Adjusted Visits/Capita(5)
0-10 mi	$.47	11872	1250	9.500	7.970
11-20 mi	$1.40	6497	4027	1.610	3.390
21-30 mi	$2.33	1770	7621	.232	1.443
31-40 mi	$3.27	829	7852	.106	.606
41-50 mi	$4.20	2502	11545	.217	.257
51-60 mi	$5.13	2977	18029	.165	.109
61-70 mi	$6.06	2683	25490	.105	.046
71-80 mi	$7.00	4022	12245	.328	.020
81-90 mi	$7.93	760	70722	.011	.0083

(1) Cost is determined by multiplying the miles from the center of each zone by the cost per mile (9.3¢/mi).

(2) Days hunted are assumed to be equivalent to the number of visits to the site from the corresponding distance zone. Data were obtained from the hunter survey.

(3) The population is that of the portion of the zone sampled in the hunter survey.

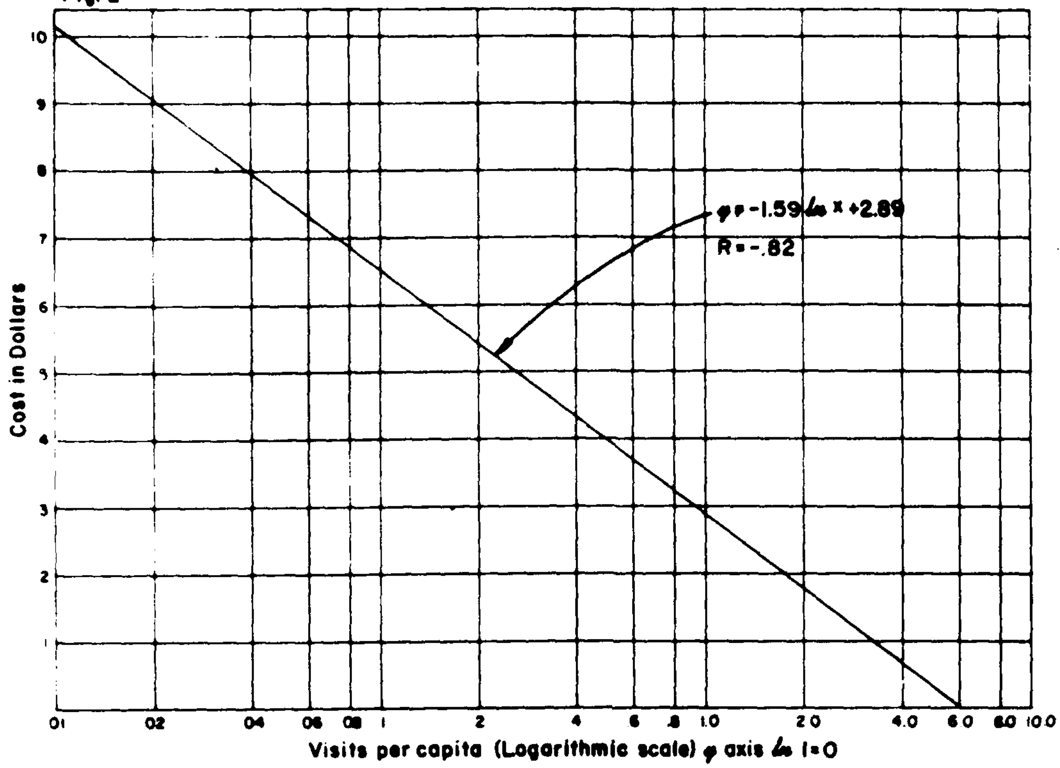
(4) Visits per capita are calculated by dividing visits from each zone by the population of the portion of the zone which was sampled.

(5) The adjusted visits per capita were determined using the equation for the line of best fit determined with regression analysis (Figures 1 and 2). The cost (y) was used in this equation to solve for the adjusted visits per capita (x).

KINDRED DAM

Individual Demand Curve

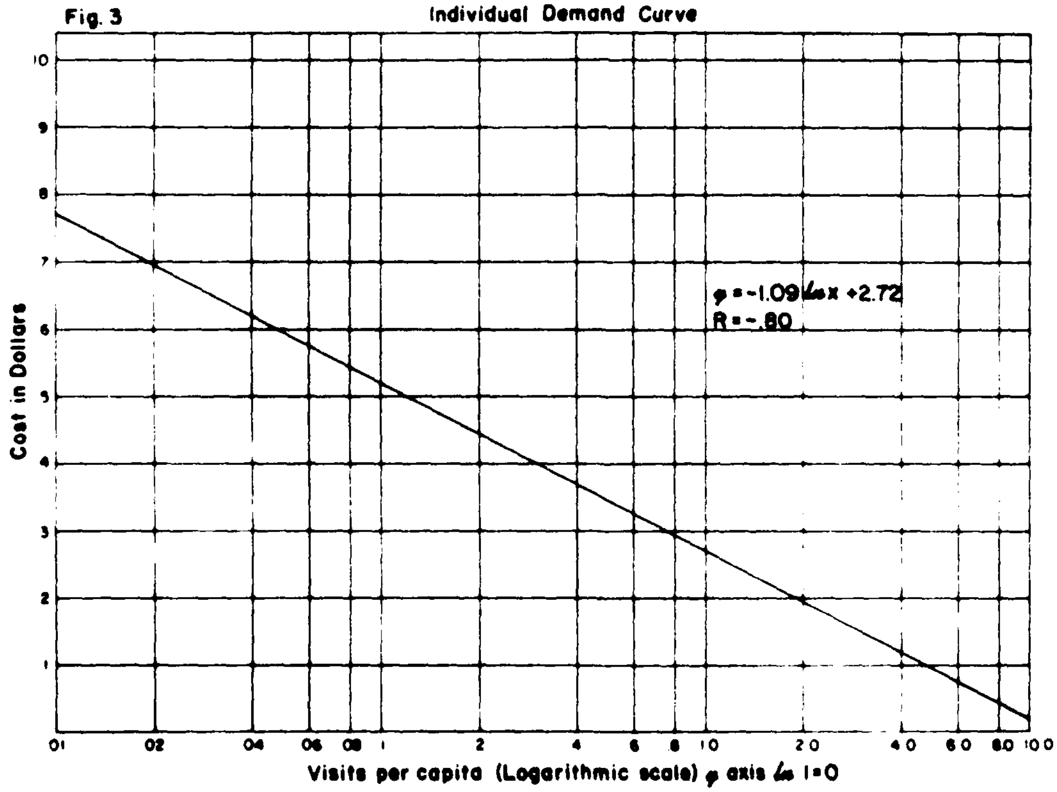
Fig. 2



LAKE ASHTABULA

Individual Demand Curve

Fig. 3



Adjustments for Travel Time:

Adjustments were made for the effects of travel time on the amount of use (visits per capita). These adjustments called for construction of a new demand curve for each distance zone. The calculation of the slopes of these new demand curves is outlined below.

Formula for determination of the new slopes:

$$M_n = M_o\ (1 + hk)$$

Where M_n = slope of new demand curves
M_o = slope of original demand curve
h = \$8,231 = per capita income (Job Service, North Dakota, 1980)
(\$8,231) ÷ (230 days X 8 hours/day) = \$4.50/hour
(\$4.50/hr)(1/3) = \$1.50/hr = h
k = 2 ÷ (50 mi/hr X .0933 \$/mi) = .4287 hrs/\$

Slope of the new demand curves - Kindred area:

$$M_n = M_o\ (1 + hk)$$
$$M_n = -1.59\ (1+ (1.50)(.4287))$$
$$= -2.61$$

Slope of the new demand curves - Lake Ashtabula area:

$$M_n = M_o\ (1 + hk)$$
$$M_n = -1.09\ (1+ (1.50)(.4287))$$
$$= -1.79$$

The new demand curves specified with the above adjustments are shown in Figures 4 and 5. Tables 3 and 4 show the new time-adjusted visits per capita for each zone.

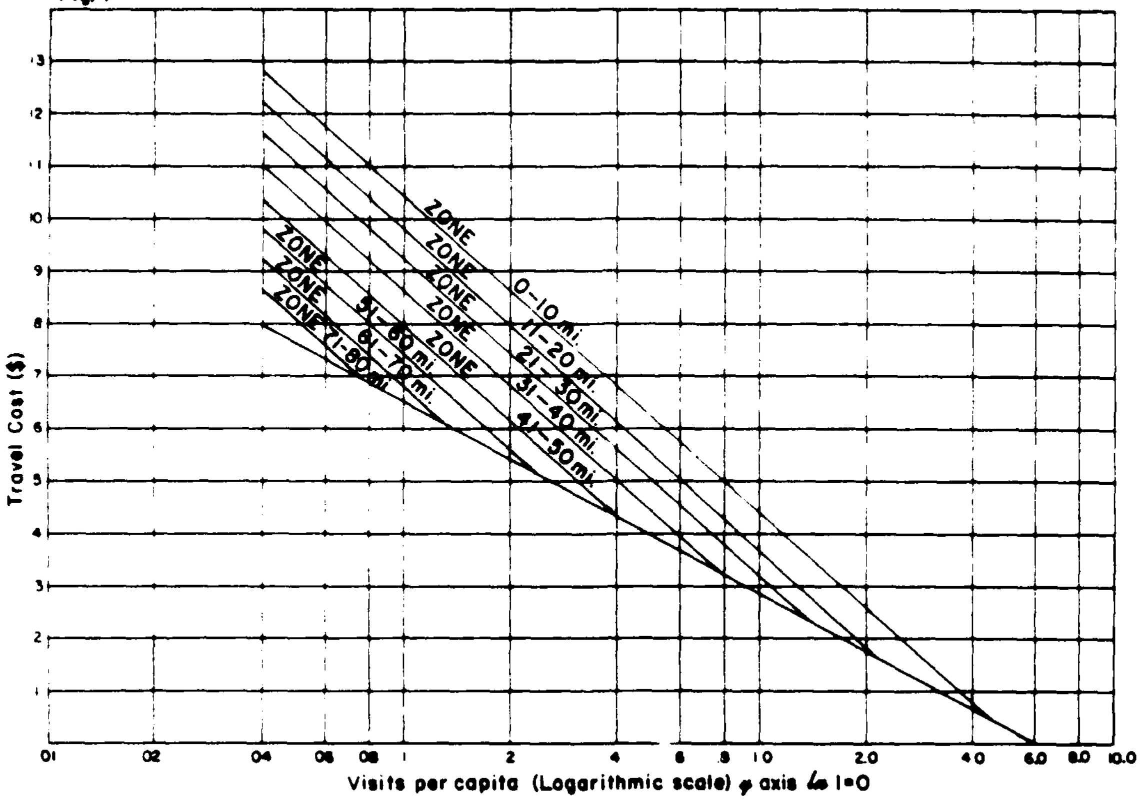
Construction of the Aggregate Demand Curve:

The time adjusted visits per capita for each zone from Tables 3 and 4 are multiplied by the population of the entire zone to give the total number of visits from that zone. Tables 5 and 6 expand Tables 3 and 4 and show the total visits for each zone at the various trip costs.

KINDRED DAM

Time Adjusted Individual Demand Curves for Each Zone

Fig. 4



LAKE ASHTABULA

Time Adjusted Individual Demand Curves for Each Zone

Fig. 5

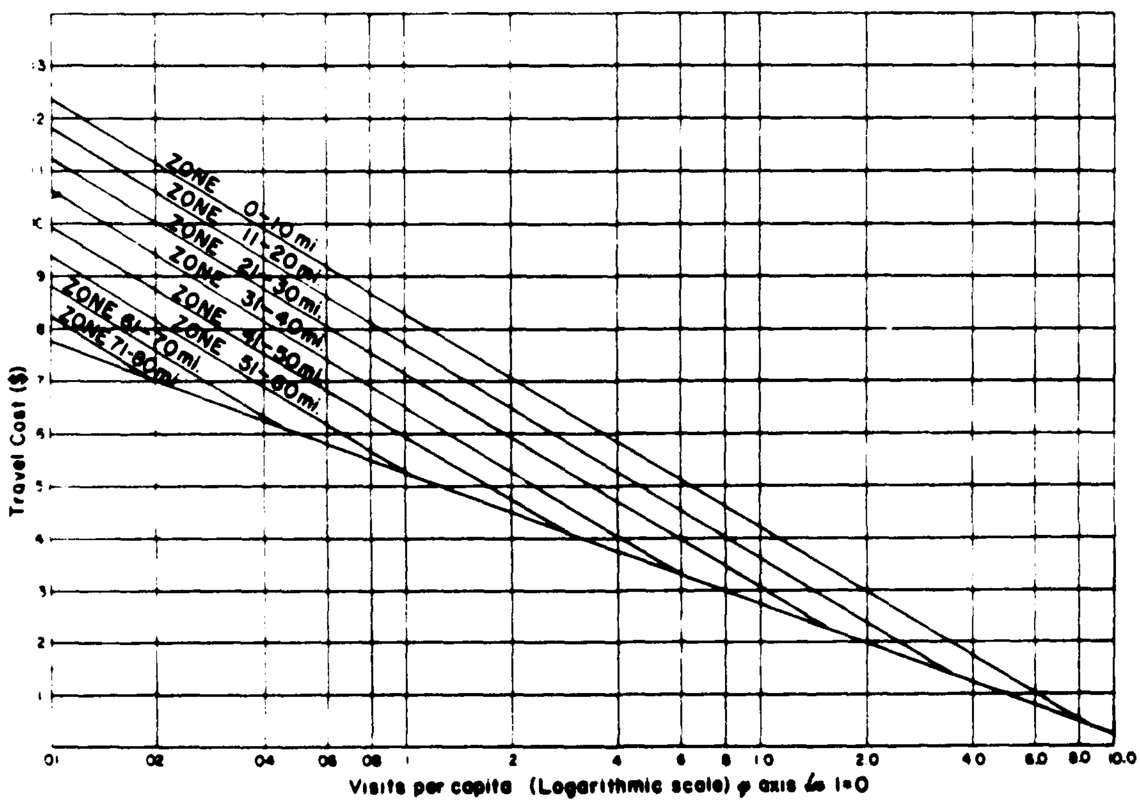


Table 3: Time adjusted visits per capita for each zone at increasing cost increments - Kindred Dam area

	ZONE								
	0-10 mi	11-20 mi	21-30 mi	31-40 mi	41-50 mi	51-60 mi	61-70 mi	71-80 mi	81-90 mi
Total trip costs	visits/ capita	visits/ capita	visits/ capita	visits/ capita	visits/ capita	visits/ capita	visits/ capita	visits/ capita	visits/ capita
.47	4.510								
1.40	3.158	2.517							
2.33	2.211	1.757	1.390						
3.27	1.542	1.226	.969	.775					
4.20	1.080	.858	.679	.543	.432				
5.13	.756	.601	.475	.380	.302	.239			
6.06	.529	.421	.333	.266	.212	.167	.133		
7.00	.369	.293	.232	.186	.148	.117	.0928	.0740	
7.93	.258	.205	.162	.130	.103	.0817	.0649	.0518	.041
8.86	.181	.144	.114	.0909	.0724	.0572	.0455	0	0
9.79	.127	.101	.0797	.0637	.0507	.0401	0		
10.72	.0887	.0705	.0558	.0446	0	0			
11.65	.0621	.0494	0	0					
12.58	.0435	0							
13.51	0								

Rates of use less than .04 → zero use.

Table 4: Time adjusted visits per capita for each zone at increasing cost increments - Lake Ashtabula area

	ZONE								
	0-10 mi	11-20 mi	21-30 mi	31-40 mi	41-50 mi	51-60 mi	61-70 mi	71-80 mi	81-90 mi
Total Trip costs	visits/ capita	visits/ capita	visits/ capita	visits/ capita	visits/ capita	visits/ capita	visits/ capita	visits/ capita	visits/ capita
.47	7.970								
1.40	4.733	3.390							
2.33	2.811	2.013	1.440						
3.27	1.660	1.183	.851	.606					
4.20	.986	.706	.505	.360	.257				
5.13	.586	.419	.300	.214	.153	.109			
6.06	.348	.249	.178	.127	.0907	.0647	.0464		
7.00	.205	.147	.105	.0750	.0535	.0382	.0274	.0196	
7.93	.122	.0874	.0625	.0445	.0318	.0227	.0163	.0116	.0083
8.86	.0725	.0519	.0371	.0265	.0189	.0135	.0097	0	0
9.79	.0430	.0308	.0220	.0157	.0112	.0080	0		
10.72	.0256	.0183	.0131	.0093	0	0			
11.65	.0152	.0109	0	0					
12.58	.00902	0							
13.51	0								

Rates of use less than .008 → zero use.

Table 5: Expansion of Table 4 to show total visits at the various trip costs - Kindred Dam Area

Additional Trip costs[3]	ZONE: 0-10 mi pop. 12[illegible]0[1] trip cost	total visits[2]	11-20 mi pop. [illegible][1] trip cost	total visits[2]	21-30 mi pop. [illegible][1] trip cost	total visits[2]	31-40 mi pop. 22829[1] trip cost	total visits[2]	41-50 mi pop. [illegible][1] trip cost	total visits[2]	51-60 mi pop. 5639[1] trip cost	total visits[2]	61-70 mi pop. 7545[1] trip cost	total visits[2]	71-80 mi pop. 23084[1] trip cost	total visits[2]	81-90 mi pop. 8571[1] trip cost	total visits[2]
0	.47	5728	1.40	14844	2.33	19357	3.27	17692	4.20	32019	5.13	1348	6.06	1003	7.00	1708	7.93	351
.93	1.40	4011	2.33	10391	3.27	13494	4.20	12396	5.13	22383	6.06	942	7.00	700	7.93	1196	8.86	0
1.86	2.33	2808	3.27	7251	4.20	9456	5.13	8675	6.06	15713	7.00	660	7.93	490	8.86	0		
2.80	3.27	1958	4.20	5074	5.13	6615	6.06	6073	7.00	10969	7.93	461	8.86	343				
3.73	4.20	1372	5.13	3554	6.06	4637	7.00	4246	7.93	7634	8.86	323	9.79	0				
4.66	5.13	960	6.06	2490	7.00	3231	7.93	2968	8.86	5366	9.79	226						
5.59	6.06	672	7.00	1733	7.93	2256	8.86	2075	9.79	3758	10.72	0						
6.53	7.00	469	7.93	1212	8.86	1588	9.79	1454	10.72	0								
7.46	7.93	328	8.86	852	9.79	1110	10.72	1018										
8.39	8.86	230	9.79	597	10.72	777	11.65	0										
9.32	9.79	161	10.72	417	11.65	0												
10.25	10.72	113	11.65	292														
11.18	11.65	79	12.58	0														
12.11	12.58	55																
13.04	13.51	0																

1. Population of the entire zone
2. Total visits is determined by multiplying the visits per capita at the various trip costs from Table 4 by the total population of the zone.
3. Trip costs are increased in increments of $0.93 because the difference between travel costs from two adjacent zones is $0.93.

Table 6 : Expansion of Table 4 to show total visits at the various trip costs - Lake Ashtabula

	ZONE:																	
	0-10 mi pop. 1250[1]		11-20 mi pop. 4027[1]		21-30 mi pop. 7621[1]		31-40 mi pop. 10747[1]		41-50 mi pop. 14952[1]		51-60 mi pop. 35696[1]		61-70 mi pop. 38965[1]		71-80 mi pop. 67539[1]		81-90 mi pop. 85861[1]	
Additional trip costs[3]	trip cost	total visits[2]	trip cost	total visits[2]	trip cost	total visits[2]	trip cost	total visits[2]	trip cost	total visits[2]	trip cost	total visits[2]	trip cost	total visits[2]	trip cost	total visits[2]	trip cost	total visits[2]
0	.47	9962	1.40	13652	2.33	10974	3.27	6513	4.20	3843	5.13	3891	6.06	1808	7.00	1324	7.93	713
.93	1.40	5916	2.33	8106	3.27	6485	4.20	3869	5.13	2288	6.06	2310	7.00	1068	7.93	783	8.86	0
1.86	2.33	3514	3.27	4788	4.20	3849	5.13	2300	6.06	1356	7.00	1364	7.93	635	8.86	0		
2.80	3.27	2075	4.20	2843	5.13	2286	6.06	1365	7.00	800	7.93	810	8.86	378				
3.73	4.20	1233	5.13	1687	6.06	1357	7.00	806	7.93	475	8.86	482	9.79	0				
4.66	5.13	732	6.06	1003	7.00	800	7.93	478	8.86	283	9.79	286						
5.59	6.06	435	7.00	592	7.93	476	8.86	285	9.79	167	10.72	0						
6.53	7.00	256	7.93	352	8.86	283	9.79	169	10.72	0								
7.46	7.93	152	8.86	209	9.79	168	10.72	100										
8.39	8.86	91	9.79	124	10.72	100	11.65	0										
9.32	9.79	54	10.72	74	11.65	0												
10.25	10.72	32	11.65	43														
11.18	11.65	19	12.58	0														
12.11	12.58	11																
13.04	13.51	0																

1. Population of the entire zone.
2. Total visits is determined by multiplying the visits per capita at the various trip costs from Table 4 by the total population of the zone.
3. Trip costs are increased in increments of \$0.93 because the difference between travel costs from two adjacent zones is \$0.93.

The row total for total visits in Tables 5 and 6 gives the overall total visits to the site which could be expected at a given level of additional trip cost. These overall total visits at the various levels of additional trip cost are summarized in Tables 7 and 8.

Table 7: Total anticipated visits at various levels of additional trip cost.

KINDRED

Additional Trip Cost (1)	Total Visits
.00	94050 (2)
.93	65513
1.86	45053
2.80	31493
3.73	21766
4.66	15241
5.59	10494
6.53	4723
7.46	3308
8.39	1604
9.32	578
10.25	405
11.18	79
12.11	55

Table 8: Total anticipated visits at various levels of additional trip cost.

ASHTABULA

Additional Trip Cost (1)	Total Visits
.00	52680
.93	30825
1.86	17806
2.80	10557
3.73	6040
4.66	3582
5.59	1955
6.53	1060
7.46	629
8.39	315
9.32	128
10.25	75
11.18	19
12.11	11

(1) Trip costs are increased in increments of $.93 because that is the difference between travel costs from two adjacent zones.

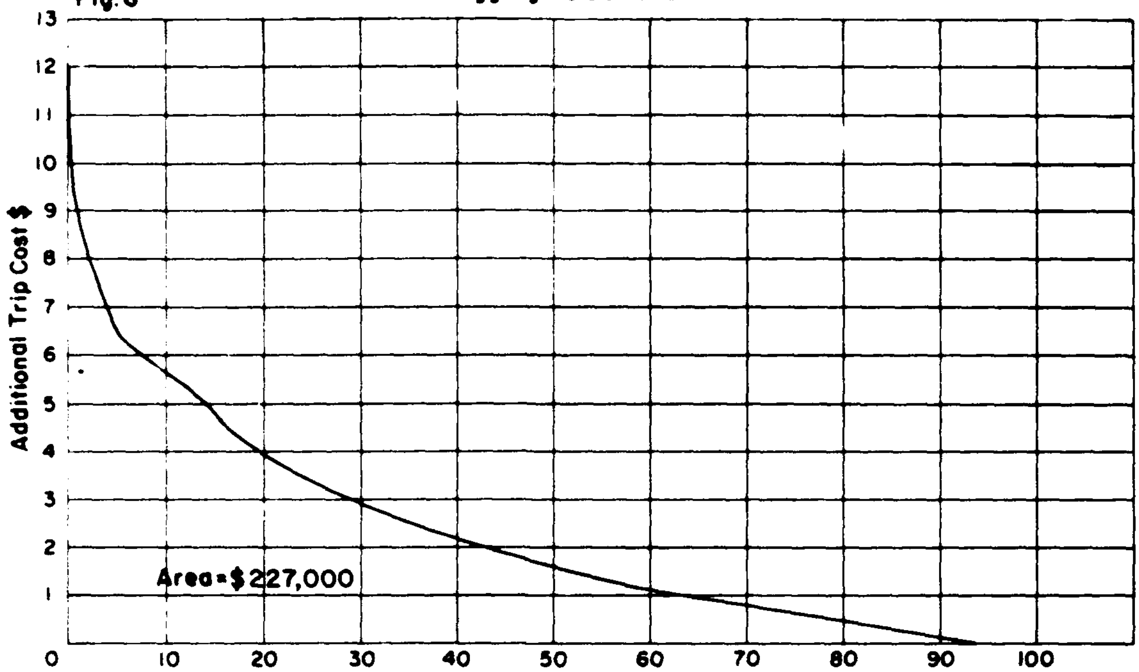
(2) This figure is derived from the information in Table 5, and is the sum of the total visits for each zone at the $.00 cost level. The other "total visit" figures in Tables 7 and 8 are calculated in a similar fashion.

The information in Tables 7 and 8 is used to construct the aggregate demand curves shown in Figures 6 and 7. The consumers' surplus enjoyed by the hunters at these two sites is the area under these demand curves. This area is determined by planimeter, and gives a value of $227,000 for hunting at the Kindred Dam site, and $91,000 for hunting at the Lake Ashtabula site.

KINDRED DAM

Aggregate Demand Curve

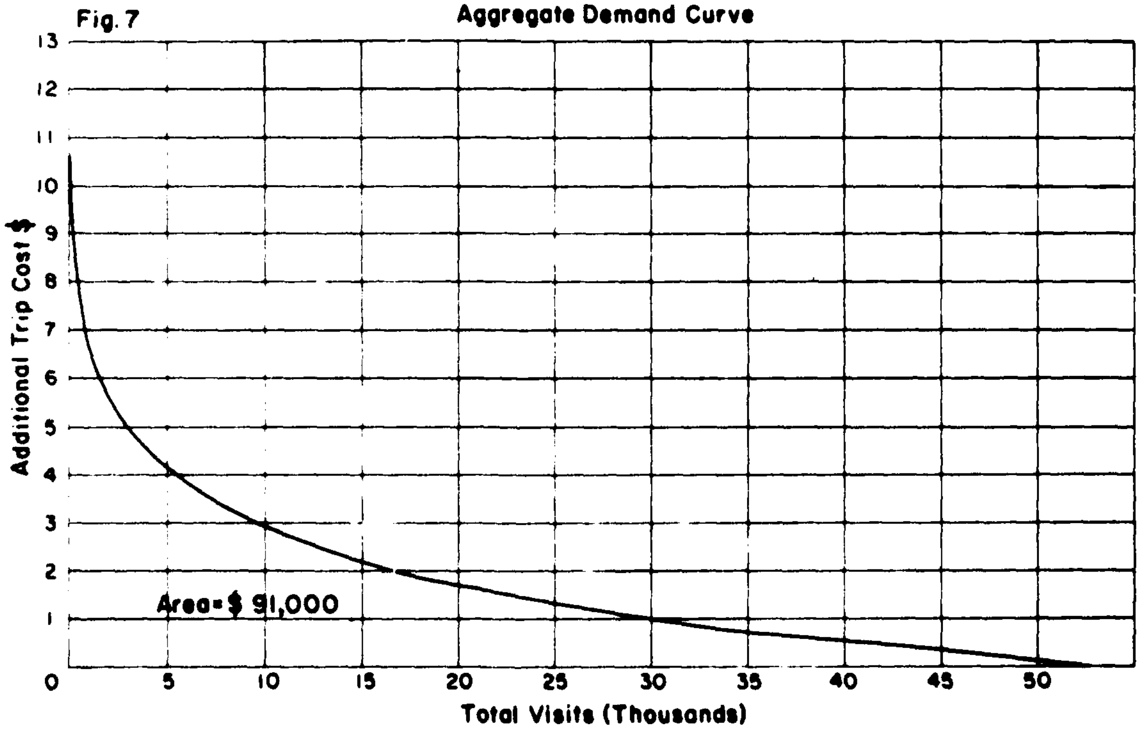
Fig. 6



LAKE ASHTABULA

Aggregate Demand Curve

Fig. 7



Calculation of Willingness-to-Pay:

Total annual willingness-to-pay is the sum of consumers' surplus and any site-specific expenditures. In this evaluation, site-specific expenditures are the onsite time costs. To determine onsite-time costs, the number of visits to the site under existing conditions (total visits at the \$.00 cost level, Tables 7 and 8) is multiplied by the value per day:

value per day[1] = 1/3 (average hourly wage rate)(hours hunted per day)
= 1/3 (4.50)(8)
= \$12.00

Table 9: Calculation of onsite time costs

	Total visits	Onsite time costs
Kindred Dam	94050	\$1,129,000
Lake Ashtabula	52680	\$ 632,000

The values from Table 9 are added to the consumers' surplus values (\$227,000-Kindred Dam, \$91,000-Lake Ashtabula) to give the estimated total annual willingness-to-pay. The resulting values are \$1,356,000 for the Kindred Dam area, and \$723,000 for the Lake Ashtabula area.

DISCUSSION

Assumptions:

Nine assumptions restrict application of the travel cost method. Five of these assumptions concern the travel cost method in general (Sinden and Woorell, 1979); the remaining four assumptions are necessary to allow use of the hunter survey data. The following is a list of these assumptions with a brief explanation of how well they fit the hunters in the Sheyenne River Basin.

(1) The average hourly wage rate was taken from Job Service, North Dakota, 1979. One-third of this value is used under guidance given in ER 1105-2-300, pg. A-69.

a. <u>Only two factors (cost of travel and travel time) will affect user demand</u>. Dwyer et al. (1977) and the National Academy of Sciences (1975) list the availability of substitute sites as an additional factor which can have significant effects on the estimated willingness-to-pay. They state that underestimation of total willingness-to-pay will result from neglecting the effects of substitute sites if there is a positive correlation between the availability of substitute sites and distance traveled (i.e., those users with high travel distance also have a high availability of similar substitute sites). In the Kindred Dam and Lake Ashtabula areas, this positive correlation does not exist (i.e., those users with high travel distance do not have a high availability of similar substitute sites). Therefore, the effects of the availability of substitute sites can be neglected without underestimating hunter willingness-to-pay. Several other factors will also affect user demand; however, the effects will be minor and therefore will not significantly change the estimate.

b. <u>Travel cost is a reliable proxy for price when adjustments for travel time are made</u>. This assumption is basic to any travel cost evaluation. If it were not valid, all travel cost evaluations would yield false results. Since this type of evaluation is recommended in ER 1105-2-300 and by Dwyer, Kelly and Bowes (1977), it is assumed that this assumption is valid.

c. <u>All users receive the same total benefit. This benefit is equal to the travel cost of the marginal (most distant) user when adjustments for travel time are made</u>. This assumption implies that the value of hunting for one user is the same for all users. It then follows that the socio-economic condition of the user does not affect the value they receive from using the site. This assumption is questioned by some authorities (Leitch, 1975; and Sinden, 1974); however, research into its validity is beyond the scope of this evaluation.

d. The consumers' surplus of the marginal (most distant) user is zero. This means that if there is an increase in the travel costs from the most distant zone, the use from that zone will fall to zero. The distance zones in this travel cost evaluation were designated so that this assumption would be true. The last distance zone was set at 90 miles because the hunter survey indicated almost no use came from zones with higher travel costs.

e. Once adjustments for travel time are made, people in all distance zones would consume the same quantity of the activity at a given monetary cost. That is, the demand curves for all distance zones have the same slope. In this monetary evaluation, no reason has been found to question the validity of this assumption.

f. This monetary evaluation underestimates total willingness-to-pay because it does not consider non-resident hunter use. This assumption is made because data on non-resident hunter use of the study area is not available. The estimate produced in this monetary evaluation must therefore be used under the constraint that it neglects an important block of users, and probably underestimates total willingness-to-pay.

g. The part of a distance zone which was sampled gives the same rate of use as the entire zone. This is a valid assumption if a large portion of the distance zone is sampled; however, the assumption is more tenuous when use rates from a small portion of the zone are expanded to give the use rate for the entire zone. For the Kindred Dam site, all distance zones were well sampled; therefore, the rates of use should be fairly reliable. For the Lake Ashtabula site, the rates of use for the outer distance zones are based on sampling of only a small portion of the zone,making them less reliable.

h. <u>The data produced by the one-season (1979) survey of hunters describe average use patterns for the study area</u>. There were 22,759 resident general hunting licenses issued for the 1979 hunting season in the 10 counties sampled during the hunter survey. On the average, 22,955 resident general hunting licenses were issued per year over the last 10 years. These hunting license data show that hunter use in 1979 was very similar to use during other years.

i. <u>One day hunted is the same as one visit to the site</u>. <u>That is, each hunter made one round-trip journey from home to the hunting site for each day hunted</u>. This assumption neglects overnight use by the hunters. Undoubtedly, some hunters from the outer distance zones stayed overnight in the area; however, since very little use is contributed by the outer zones, overnight trips should not significantly affect the estimate.

<u>Reliability of the Estimated Willingness-to-Pay</u>:

The travel cost method predicts a higher number of total visits at existing cost levels than the total number of visits which were found through the survey of hunters (compare Tables 1 and 2 to Tables 7 and 8). This difference may be the result of the effects of two factors. First, although several variables affect the rate of visits, only the effects of the travel cost variable were described in the regression analysis. Second, interpretation of the hunter survey data may have caused exaggeration of the number of visits from zones 1 and 2, resulting in misspecification of the individual demand curve. The number of visits predicted with the travel cost method in the Kindred area is 88% higher than the total number of visits found through the hunter survey and 36% higher for the Lake Ashtabula area. The effect of this difference may be an overestimation of the total willingness-to-pay value.

One additional source of error is the measurement of distance traveled to the site in a straight line, when actual driving distance may be much greater. To

partially compensate for this, the actual driving distance for all cities with populations over 1,000 was calculated, and their populations added to the appropriate distance zone. Total compensation for this is not possible since the specific origin for each hunter surveyed is not known.

The largest portion of the estimated willingness-to-pay value comes from the onsite time expenditures. Since there is a lack of hunter socio-economic data for the study area, the onsite time values are based on an arbitrary trade-off between time and money. For this reason, these values are not as reliable as the estimated consumer surplus values, and limit the accuracy of the total willingness-to-pay figure.

SUMMARY

The travel cost method was used to estimate annual willingness-to-pay for hunting under existing conditions in the Kindred Dam and Lake Ashtabula areas. Using travel costs as a proxy for price, a demand curve was constructed showing how total visits to the sites decline with increased prices. The consumers' surplus enjoyed by the area's hunters was calculated from the demand curve and then added to the hunters' expenditures. These expenditures are restricted to site-specific expenditures and therefore only include the value of the time spent hunting. The following table summarizes the estimated willingness-to-pay for hunting under existing conditions as determined by the travel cost method.

Table 10: Total annual willingness-to-pay under existing conditions (travel cost method)

Site:	Consumers' surplus	Expenditures	Total annual willingness-to-pay
Kindred Dam	$227,000	$1,129,000	$1,356,000
Lake Ashtabula	$ 91,000	$ 632,000	$ 723,000

UNIT DAY METHOD - EXISTING CONDITIONS

This unit day method, like the travel cost method, attempts to estimate the value of hunting in the Kindred Dam and Lake Ashtabula areas. The unit day method relies on professional judgment and therefore does not produce as reliable an estimate as the travel cost method (Dwyer et al., 1977; ER 1105-2-300). However, the unit day method has been widely used in the past, and provides a basis for comparison of estimates produced for several other projects. For this reason, the unit day method is applied to the Kindred Dam and Lake Ashtabula areas.

METHODOLOGIES

The unit day method utilizes two variables: (1) the number of days spent hunting in the study area (user days), and (2) an average dollar estimate of the value of one day of hunting. The product of these two variables gives an estimate of total hunting value.

The total number of days spent hunting in the Kindred Dam and Lake Ashtabula areas was determined through a survey of hunters in Barnes, Griggs, Ransom, Richland, Cass, LaMoure, Sargent, Steele, Stutsman, and Traill Counties in southeastern North Dakota. The survey was designed specifically to determine use in the two project areas. It provides data on the total number of days spent hunting, and a breakdown of this figure according to the species hunted. Since the sample interval was small, and most of the use comes from the counties surveyed, the hunter survey should give a reliable estimate of current user days. (See Table 11 for a summary of this data.)

An estimate of the average value of one day of hunting is then necessary to determine total hunting value. A wide range of estimates for average daily hunting value has been published, three of which are used in this evaluation to give a range to the estimated total value. Two of these values were determined through

surveys of North Dakota hunter expenditures (Sorenson, 1975; and U.S. Fish and Wildlife Service, 1975) and are therefore specific to the State of North Dakota. They include non-site-specific expenditures such as food, lodging, and equipment. The value recommended for use in this type of evaluation is produced through Water Resources Council (WRC) procedures (ER 1105-2-300). It is a site-specific value, and does not include the non-site-specific expenditures.

The WRC value is produced using a point rating method and professional judgment (see Figure 8) to rate the quality of hunting at the site. The point rating for the site is then converted to a dollar figure, using the most recently published conversion table. The dollar value produced is an estimate of the daily recreation benefits from hunting in the Kindred Dam and Lake Ashtabula areas. When this value is multiplied by the number of days hunted, an estimate of annual recreation benefits is achieved.

RESULTS

The total number of user days was determined through a survey of the area's hunters. Table 11 gives a breakdown of the total days hunted (by type of hunting) in the Kindred Dam and Lake Ashtabula areas.

Table 11: Days spent hunting (by type of hunting)

	Big game(1)	Other hunting(2)	Total
Kindred Dam	11,860	44,350	56,210
Lake Ashtabula	3,103	38,263	41,366

(1) Includes deer.

(2) Includes grouse, partridge, pheasant, waterfowl, rabbit, squirrel, fox, other.

Several studies have been done to determine average daily value for hunting. The three sets of values used in this evaluation are summarized in Table 12. Values determined through WRC methods represent estimated daily recreation benefits. The other values represent estimates of average daily expenditures by hunters.

Table 12: Average daily values as determined by three methods (values in dollars per day hunted)

	Big Game		Other Hunting	
	Kindred	Ashtabula	Kindred	Ashtabula
1. WRC methods	$14.30	$11.60	$ 3.86	$ 3.50
2. U.S. Fish and Wildlife (1975)(1)	$51.54	$51.54	$21.17	$21.17
3. Sorenson (1975)(2)	$43.71	$43.71	$22.96	$22.96

(1) The values shown are 1975 values (USFWS, 1975, Tables 1 and 10) which have been adjusted to 1980 price levels using a 1.52 consumer price index multiplier.

(2) The values shown are 1973 values (Sorenson, 1975, pg. 91), which have been adjusted to 1980 price levels using a 1.84 consumer price index multiplier.

The values produced through the WRC methods are specified as those which must be used for this type of evaluation (ER 1105-2-300). Figure 8 shows the point rating system which was used to determine the WRC values. Figure 9 is a brief summary of the justification for selecting the specific point values. Big game (deer) hunting was evaluated under the specialized recreation criteria because prime deer habitat and good deer hunting areas are scarce in North Dakota. The potential loss of this recreational resource in the Kindred Dam and Lake Ashtabula areas would have State-wide impacts.

The estimated total hunting value is obtained by multiplying the dollar values from Table 12 by the number of days from Table 11. The estimates produced are summarized in Table 13.

Figure 8: Point Rating System (WRC)

Table 6-3 2 - Guidelines for Assigning Points for General Recreation

Criteria	Judgment Factors				
a) Recreation Experience	Two general activities 3/	Several general activities	Several general activities; one high quality value activity 4/	Several general activities; more than one high quality high activity	Numerous high quality value activities; some general activities
Total Points: 30 Point Value:	0-4	5-10	11-16	17-23	24-30
b) Availability of Opportunity 2/	Several within 1 hr. travel time; a few within 30 min. travel time	Several within 1 hr. travel time; none within 30 min. travel time	One or two within 1 hr. travel time; none within 45 min. travel time	None within 1 hr. travel time	None within 2 hr. travel time
Total Points: 18 Point Value:	0-3	4-6	7-10	11-14	15-18
c) Carrying Capacity 1/	Minimum facility development for public health and safety	Basic facilities to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Total Points: 14 Point Value:	0-2	3-5	6-8	9-11	12-14
d) Accessibility	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, high standard road to site good access within site
Total Points: 18 Point Value:	0-3	4-6	7-10	11-14	15-18
e) Environmental Quality	Low esthetic factors 5/ exist that significantly lower quality 6/	Average esthetic quality; factors exist that lower quality to minor degree	Above average esthetic quality; any limiting factors can be reasonably rectified	High esthetic quality, no factors exist that lower quality	Outstanding esthetic quality; no factors exist that lower quality
Total Points: 20 Point Value:	0-2	3-6	7-10	11-15	16-20

1/ Value should be adjusted for overuse.
2/ Value for water-oriented activities should be adjusted if significant seasonal water level changes occur.
3/ General activities include those that are common to the region and that are usually of normal quality. This includes picnicking, camping, hiking, riding, cycling, and fishing and hunting of normal quality.
4/ High quality value activities include those that are not common to the region and/or Nation and that are usually of high quality.
5/ Major esthetic qualities to be considered include geology and topography, water, and vegetation.
6/ Factors to be considered in lowering quality include air and water pollution, pests, poor climate, and unsightly adjacent areas.
7/ Likelihood of success at fishing and hunting.
8/ Intensity of use for activity.

Table 6-3 3 - Guidelines for Assigning Points for Specialized Recreation

Criteria	Judgment Factors				
a) Recreation Experience 8/	Heavy use or frequent crowding or other interference with use	Moderate use, other users evident and likely to interfere with use	Moderate use, some evidence of other users and occasional interference with use due to crowding	Usually little evidence of other users, rarely if ever crowded	Very low evidence of other users, never crowded
Total Points: 30 Point Value:	0-4	5-10	11-16	17-23	24-30
b) Availability of Opportunity 7/	Several within 1 hr. travel time; a few within 30 min. travel time	Several within 1 hr. travel time, none within 30 min. travel time	One or two within 1 hr. travel time, none within 45 min. travel time	None within 1 hr. travel time	None within 2 hr. travel time
Total Points: 18 Point Value:	0-3	4-5	7-10	11-14	15-18
c) Carrying Capacity 1/	Minimum facility development for public health and safety	Basic facilities to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Total Points: 14 Point Value:	0-2	3-5	6-8	9-11	12-14
d) Accessibility	Limited access by any means to site or within site	Fair access, poor quality roads to site; limited access within site	Fair access, fair road to site, fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Total Points: 18 Point Value:	0-3	4-6	7-10	11-14	15-18
e) Environmental Quality	Low esthetic factors 5/ exist that significantly lower quality 6/	Average esthetic quality; factors exist that lower quality to minor degree	Above average esthetic quality; any limiting factors can be reasonably rectified	High esthetic quality; no factors exist that lower quality	Outstanding esthetic quality; no factors exist that lower quality
Total Points: 20 Point Value:	0-2	3-6	7-10	11-15	16-20

1/ Value should be adjusted for overuse.
2/ Value for water-oriented activities should be adjusted if significant seasonal water level changes occur.
3/ General activities include those that are common to the region and that are usually of normal quality. This includes picnicking, camping, hiking, riding, cycling, and fishing and hunting of normal quality.
4/ High quality value activities include those that are not common to the region and/or Nation and that are usually of high quality.
5/ Major esthetic qualities to be considered include geology and topography, water, and vegetation.
6/ Factors to be considered in lowering quality include air and water pollution, pests, poor climate, and unsightly adjacent areas.
7/ Likelihood of success at fishing and hunting.
8/ Intensity of use for activity.

Figure [illegible]

		Recreation Experience	Availability of Opportunity	[illegible]	Accessibility	Environmental Quality	Total Points	[illegible]
Big Game (specialized recreation)	Kindred	Point value: [illegible] On the average, there are 5 hunters per square mile (Hunter Survey). Only very rarely would crowding be noticed.	Point value: [illegible] High harvest figures [illegible] the availability [illegible] habitat yield good oppor- tunity for hunter success.	[illegible]	[illegible] deer hunting [illegible] Kindred area.	Point Value: [illegible] [illegible] of the wooded area, the topography, and the diversity surrounding the Kindred site give the area high aesthetic qualities.	[illegible]	[illegible]
	Lake Ashtabula	Point value: 16 Although there are not many deer hunters in the upper end of the reservoir, there is some crowding.	Point value: [illegible] Low harvest figures and small amounts of good deer habitat yield fair [illegible] for hunter success.	[illegible] value: 8 Smaller tracts of wooded area and concentration of all deer hunters in these tracts produce adequate deer hunting facilities.	[illegible] value: 8 [illegible] accessibility to deer hunting lands is [illegible] the upper end of the reservoir. [illegible] accessibility [illegible] due to the [illegible] proportion of pri- vate lands.	Point Value: 9 Average topographic qual- ities and limited expanses of wooded areas provide above average aesthetic qualities.	51	11.60
General Hunting	Kindred	Point value: 18 The diverse habitat in the Kindred area supports a wide diversity of wild- life species, and there- fore provides good hunt- ing.	Point value: 18 High harvest figures and the availability of several game species yield good oppor- tunity for hunter success.	Point value: 10 Large tracts of wooded area and uncrowded conditions are optimum facilities for hunting.	Point value: 14 The Kindred area is readily accessible to hunters due to the large areas of publicly owned lands.	Point value: 13 The expanse of the wooded area, the topography and the diversity surrounding the Kindred site give the area high aesthetic qualities.	78	3.86
	Lake Ashtabula	Point value: 15 The reservoir provides a great variety of hunting, although most hunting lands are composed of a strip along the reservoir edge.	Point value: 18 According to the hunter sur- vey, hunters have been very successful in the Lake Ash- tabula area.	Point value: 10 General hunting lands are more widespread than deer hunting lands and therefore create optimum general hunt- ing facilities.	Point value: 8 Accessibility to hunt- ing areas is limited by the amount of pri- vate lands surround- ing Lake Ashtabula.	Point value: 9 Average topographic qual- ities and limited expanses of wooded areas provide above average aesthetic qualities.	60	3.50

(1) Dollar values are 1981 values derived from table K-3-1, Reference Handbook, U.S. WRC, 1981.

Table 13: Estimated total hunting value[1]

	Big Game Hunting		Other Hunting		Total[2]	
	Kindred (11,860 days)	Ashtabula (3,103 days)	Kindred (44,350 days)	Ashtabula (38,263 days)	Kindred	Ashtabula
1. WRC Values	$170,000	$ 36,000	$171,000	$134,000	$341,000	$170,000
2. U.S. Fish & Wildlife Values	$611,000	$160,000	$939,000	$810,000	$1,550,000	$970,000
3. Sorenson's Values	$518,000	$136,000	$1,018,000	$879,000	$1,536,000	$1,015,000

[1] Estimates have been rounded to the nearest thousand.

[2] Total value is the sum of the "Big Game" value and the "Other Hunting" value.

DISCUSSION

The following restrictive assumptions were made in the application of the unit day method to the Kindred Dam and Lake Ashtabula areas. The reliability of these assumptions is an indication of the reliability of the estimates produced in this evaluation.

(1) It is assumed that the hunter survey responses were representative of hunter use patterns in the study area.

(2) It is assumed that all hunters received the same total benefit, and an estimate of that benefit is adequately expressed by the average daily hunting value.

The first assumption is probably reliable, since the survey concentrated on the counties closest to the two study sites, and utilized a small sample interval.

The second assumption is more tenuous, because it indicates that every hunter receives the same benefit from a day of hunting. It does not account for differences among hunters in such things as socioeconomic characteristics, travel distances, or perceived value of the experience. Failure to account for these differences can result in misspecification of the daily hunting value, thereby affecting the total value for hunting in the study area.

This application of the unit day method produced a wide range of total hunting values (see Table 13, Results section) as a result of the differences in the way daily hunting values were calculated (see Table 12, Results section). The Sorenson (1975) and Fish and Wildlife Service (1975) values include non-site-specific expenditures such as food, lodging, clothing, and hunting equipment. The WRC procedure gives a subjective estimate of daily recreation benefits. If one specific value must be selected from the range presented, the WRC value should be chosen, since it is specified by ER 1105-2-300 as the value which must be used in this type of evaluation.

In contrast to the travel cost method, values produced through this unit day method are not estimtes of total willingness-to-pay. Sorenson's and Fish and Wildlife Service values are estimates of total expenditures, and an estimate of consumer's surplus would have to be added to these expenditures to get total willingness-to-pay. The WRC values are estimates of "annual recreation benefits," an undefined term which cannot be expressed in terms of willingness-to-pay.

SUMMARY

The unit day method for monetary evaluation of recreation use was applied to hunter use in the Kindred and Lake Ashtabula areas. The resulting estimates of hunting value range from $341,000 to $1,550,000 for the Kindred site, and from $170,000 to $1,015,000 for the Lake Ashtabula site. The wide range in values results from the different procedures used to calculate the daily hunting values. If one set of values must be selected for use, it should be those calculated using the WRC procedures (ER 1105-2-300).

Major flaws with the unit day method result from the failure to consider differences among hunters in such things as socio-economic characteristics, travel distances, or perceived value of the hunting experience. Other types of evaluation (e.g., travel cost evaluation) provide more reliable values, but the unit day method is the traditional method which has been widely used, and therefore provides values which can be compared to those produced in previous studies.

FUTURE CONDITIONS

In order to determine the effects of a proposed project, it is necessary to look at the difference between the with and without project conditions over the entire life of the project. Since none of the Kindred Dam proposals were included in the alternatives given for detailed consideration, the following discussion on future with and without project conditions is limited to the Lake Ashtabula area.

Future Without Project

To determine the future without project condition, the number of total visits per year in the future must be predicted. Predictions of total visits per year in the region through 1995 are given in the 1980 North Dakota State Comprehensive Outdoor Recreation Plan (SCORP).

Table 14: Anticipated total visits per year for hunting in N.D. State planning regions 5 and 6[(1)]

	1978	1979	1980	1985	1990	1995
Visits[(2)]	462,989	471,010	479,030	505,901	508,368	503,796

[(1)] These planning regions include the following counties: Cass, Ransom, Richland, Sargent, Steele, Traill, Barnes, Dickey, Foster, Griggs, LaMoure, Logan, McIntosh, Stutsman, Wells.

[(2)] Total visits were determined by adding the predicted visits for upland game, waterfowl, big game, and non-game hunting (Appendix Tables 1-8, North Dakota SCORP, 1980).

To project the levels of total visits throughout the life of the project (100 years), use was assumed to remain at the same levels as was predicted for 1995. Three reasons can be given why no further increases in total visits are anticipated after 1995.

(a) Regional population is declining (1980 SCORP).

(b) The hunting resource can only sustain a limited amount of use.

(c) Increasing energy prices will probably cause hunters to stay closer to home.

Total hunting visits in the region will therefore increase to 503,796 (7 percent increase) through 1995 and then remain at that level through 2080. Future changes in the number of total hunting visits to Lake Ashtabula are assumed to be directly proportional to these regional changes, and should also show a 7 percent increase.

Increases in total visits have a direct effect on the values produced through both the travel cost and unit day methods. Therefore, a 7 percent increase in visits will result in a 7 percent increase in the hunting resource value. Table 15 summarizes the future values for the Lake Ashtabula hunting resource in 2080.

Table 15: Calculation of future values for hunting in the Lake Ashtabula area (2080)

	Travel cost method values	Unit Day Method Values: WRC values	USFWS values	Sorensons values
Existing conditions[1]	$723,000	$170,000	$970,000	$1,015,000
Future without project conditions (2080)	$774,000	$182,000	$1,038,000	$1,086,000

[1] Existing conditions X 1.07 = future without project conditions (2080).

Future With Project

To determine future with project conditions, the effects and the scale of the potential project impacts on the total visits to the site must be determined. Of the 100,000 acres at the Lake Ashtabula site, only 1500 acres on the perimeter of the reservoir would be inundated by a 5-foot raise in the flood pool elevation.

Since flooding of this acreage would be temporary and seasonal, the actual habitat losses may be much less than the 1500-acre figure (see Appendix D for a discussion of the effects of flooding on vegetation). Therefore, the actual scale of acreage losses at the site would probably be less than 1 percent of the available area.

It is difficult to specify how these small scale losses would affect hunter use of the area. Possible significant effects could result if the acreage lost contains areas which are critical to hunting. However, this situation is not thought to exist in the Lake Ashtabula area and therefore the scale of the impacts is so small that no significant change in hunter use of the area is anticipated.

Since no significant change in hunter use of the area is anticipated, the future with project values are the same as future without project values (see Table 15). It is therefore concluded that analysis through the travel cost and unit day methods predicts no change in the dollar value of hunting at the Lake Ashtabula area as a result of the proposed action. This does not necessarily mean that impacts to wildlife habitat or populations would not occur.

SUMMARY AND CONCLUSIONS

This monetary evaluation attempted to determine wildlife mitigation acreage by assessing project impacts on the estimated value of hunting. To make this assessment required assuming a direct relationship between dollars of hunting value and acres of wildlife habitat. Hunting value estimates were produced for existing conditions, future without project conditions, and future with project conditions. A comparison of future with project conditions to future without project conditions was attempted in order to determine potential project impacts and necessary mitigation lands.

Two different methods, the travel cost method and the unit day method, were used to determine the hunting value estimates. The travel cost method

calculates consumers' surplus using a demand curve which shows how total visits to the site decrease with increases in price. The consumers' surplus value is then added to onsite time costs to estimate total willingness-to-pay. With the unit day method, hunting value is the product of total visits to the site and a value per visit. Since three different estimates of the value per visit were used, three different sets of hunting values were produced. Table 16 summarizes all values produced through the two methods used, and gives a brief synopsis of the factors considered in each value.

Analysis of future conditions in the Lake Ashtabula area was based on use predictions made in the North Daktoa SCORP. The predicted 7-percent increase in total visits also increased future values for all methods by 7 percent.

Comparison of the future with project condition to the future without project condition showed no difference in hunting value. It was concluded that the small scale of acreage lost due to the project would result in no significant changes in the estimated values produced through the unit day or travel cost methods.

Although this monetary evaluation concluded that no effects on hunting value would result from the proposed action, it is not possible to expand this conclusion to exclude the need for wildlife mitigation lands. The basic assumption for determination of wildlife mitigation lands was that there is a direct relationship between hunting value and the availability of wildlife habitat. This assumption may be true in the gross sense (i.e., large scale habitat losses would affect hunting); however, small scale changes in the available habitat do not cause corresponding changes in hunting use. For assessment of the effect of these small scale losses on wildlife and determination of wildlife mitigation lands, a habitat or wildlife based evaluation is recommended.

Table 16: Summary of the costs considered and the estimates produced in the monetary evaluation

		Travel Cost Method Values(1)	Unit Day Method Values		
			WRC values(1)	USFWS values	Sorenson's values
VALUES	Existing conditions - Kindred	$1,356,000	$341,000	$1,550,000	$1,536,000
	Existing conditions-L. Ashtabula	$ 723,000	$170,000	$ 970,000	$1,015,000
	Future without - L. Ashtabula	$ 774,000	$182,000	$1,038,000	$1,086,000
	Future with - L. Ashtabula	$ 774,000	$182,000	$1,038,000	$1,086,000
COSTS OR VALUES GIVEN DIRECT CONSIDERATION IN THE ESTIMATE PRODUCED(2)	Recreational value of the hunting experience	X	X	X	X
	Expenditures - site-specific	X			
	Onsite time costs	X			
	Travel time costs	X			
	Total willingness-to-pay	X			
	Consumers' surplus	X			
	Expenditures-non-site-specific			X	X
	Fees, licenses, stamps			X	X
	Hunting equipment costs (Guns, ammunition, etc.)			X	X
	Food and lodging			X	X
	Transportation			X	X
	Clothing				X
	Dogs and dog care				X
	Trophies and taxidermy				X
	Crowding at the site		X		
	Number of game species		X		
	Availability of opportunity		X		
	Carrying capacity		X		
	Accessibility to site		X		
	Aesthetic appeal		X		
	Non-consumptive wildlife uses				

(1) Values produced through these procedures are accepted by the WRC and ER 1105-2-300.

(2) These costs or values were given direct consideration in the methodology which produced the estimate.

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